AIR CONDITIONING HEATING AND VENTILATING

JANUARY 1961

For the Engineer
Engaged in DESIGN
APPLICATION
ESTIMATING
SPECIFICATION
and LAYOUT

IN THIS ISSUE

Storm Sewer Design for Big Building Sites 55

Design of Snow Melting Systems for Houses ... 51

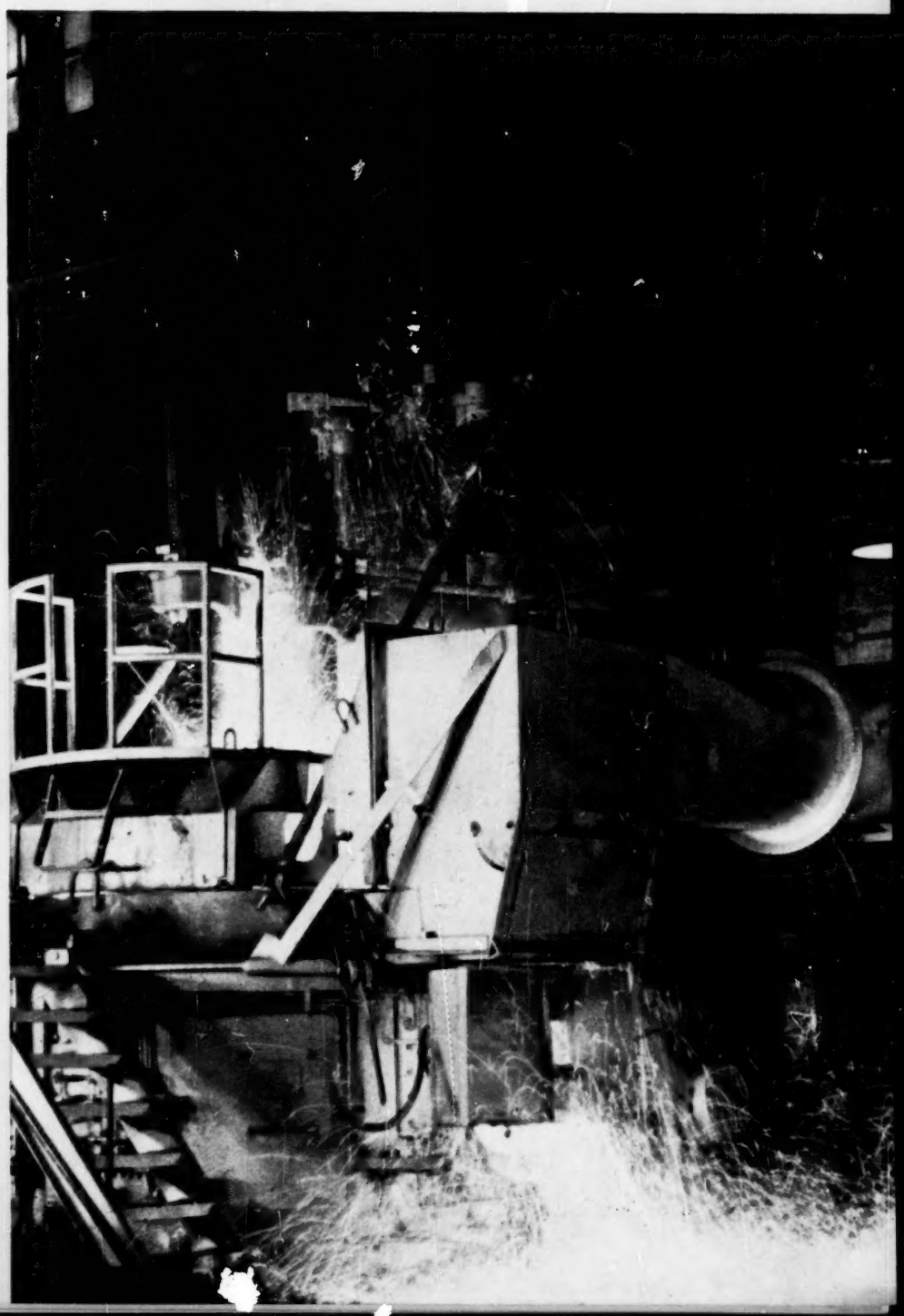
Packaged Unit Performance at Off-Peak Loads 77

Data Sheet:
Summer Design Temperatures Abroad .. 73

Detail Sheet
Grease and Fume Hoods 75

Full Contents on Page 3

Annual Index, 1960, Page 91



Electric steel melting furnace with roof-mounted fume-control hood during oxygen lancing phase of melt at Ohio Steel Castings Co., Springfield, Ohio. Wheelabrator installation handles as much as 31,500 cfm of fume. See page 45.

JENKINS PRACTICAL PIPING LAYOUT

84

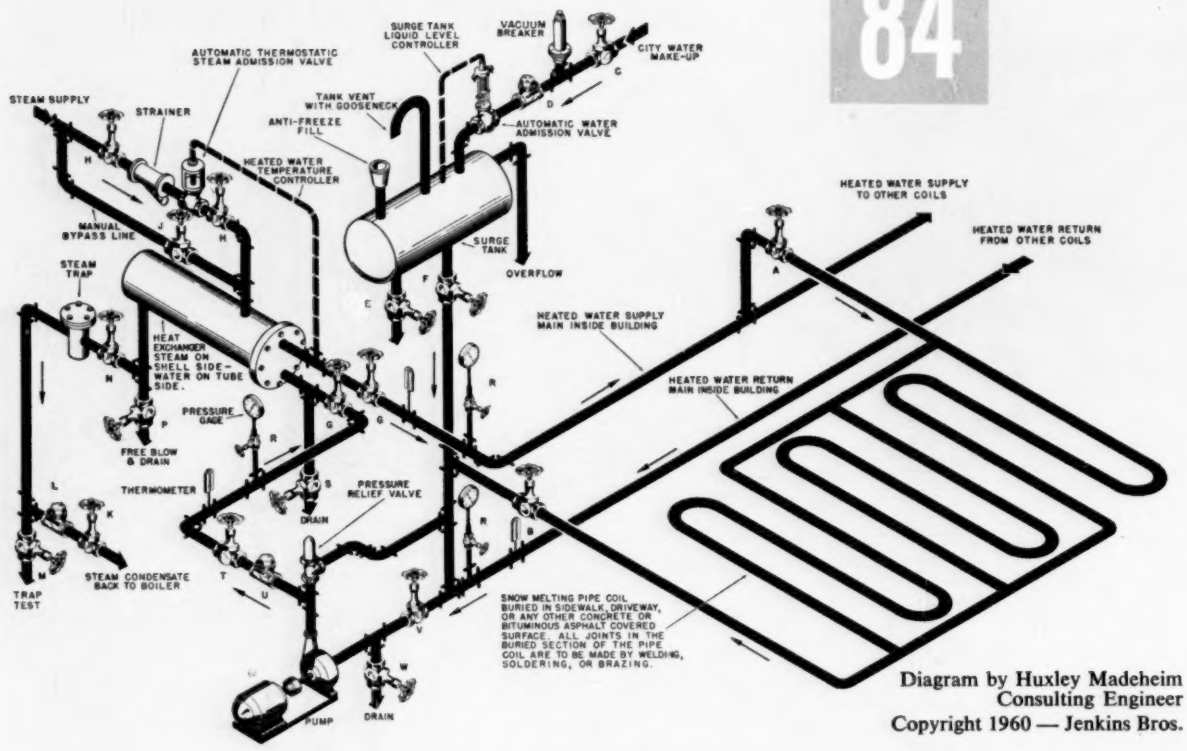

SURGE TANK LIQUID LEVEL CONTROLLER
VACUUM BREAKER
CITY WATER MAKE-UP
AUTOMATIC THERMOSTATIC STEAM ADMISSION VALVE
STEAM SUPPLY
STRAINER
TANK VENT WITH GOOSENECK
ANTI-FREEZE FILL
AUTOMATIC WATER ADMISSION VALVE
HEATED WATER TEMPERATURE CONTROLLER
HEATED WATER SUPPLY TO OTHER COILS
HEATED WATER RETURN FROM OTHER COILS
MANUAL BYPASS LINE
SURGE TANK
OVERFLOW
STEAM TRAP
HEAT EXCHANGER STEAM ON SHELL SIDE—WATER ON TUBE SIDE.
HEATED WATER SUPPLY MAIN INSIDE BUILDING
HEATED WATER RETURN MAIN INSIDE BUILDING
PRESSURE GAGE
FREE BLOW & DRAIN
THERMOMETER
PRESSURE RELIEF VALVE
DRAIN
STEAM CONDENSATE BACK TO BOILER
TRAP TEST
SNOW MELTING PIPE COIL BURIED IN SIDEWALK, DRIVEWAY, OR ANY OTHER CONCRETE OR BITUMINOUS ASPHALT COVERED SURFACE. ALL JOINTS IN THE BURIED SECTION OF THE PIPE COIL ARE TO BE MADE BY WELDING, SOLDERING, OR BRAZING.
PUMP
DRAIN

Diagram by Huxley Madeheim
Consulting Engineer

Copyright 1960 — Jenkins Bros.

How to plan piping connections for a SNOW MELTING SYSTEM

For controlled melting of snow and ice, use of a warm fluid circulating in pipe coils buried in paving material is rapidly expanding. Piping may be steel, wrought iron, brass or copper depending on conditions.

Conditions encountered in the specific installation should dictate details of construction, so the layout shown here cannot represent necessarily correct installation practice for every job. Some factors to be considered are severity of snowstorms, prevailing temperature, speed of removal desired, heat sources available, heat losses, hydraulic requirements.

Hydraulic requirements are determined by the amount, size and arrangement (sinuous or grid coils) of pipe as they determine size of circulator or pump. Regardless of type of pipe circuit, friction loss should be kept as nearly equal as possible between all circuits, and when necessary to obtain approximately the same pressure drop to each circuit, valves or balancing cocks are recommended.

The heat required varies with conditions but an output of 100 to 200 BTU per hr. per sq. ft. of surface has been adequate for most installations. In addition to heat output at surface, there should be an allowance of 30 to 50 per cent for back and edge losses, this being related to amount of insulation and cycle of operation as well as to fuel costs.

Air pockets or collections in the system should be avoided, and where grading conditions require different parts of pipe system to be pitched in different directions, it may be necessary to provide air vent lines from high points of pipe loops and carry vent lines to air vent valves in a curb box.

Drains are generally provided at low points for draining coils if required although annual drainage is not necessary.

As a snow melting system is fundamentally a forced circulation hot-water system, most standard practices for a hot-water system may be followed in the boiler or heat exchanger hook-up.

The system shown here uses steam heated hot water at 212°F., to which is added conventional ethylene glycol anti-freeze and a rust inhibitor.

The expansion or surge tank should be of generous size because of the greater expansion properties of water containing anti-freeze. The tank not only serves to liberate air and provide for expansion but also allows for initial filling and subsequent addition of water and anti-freeze. Its provisions should meet all code requirements including a guarantee against contamination of city water supply by a treated liquid.

Jenkins Fig. 106-A screwed end bronze globe valve, (or equivalent Fig. 1270 with socket ends, or Fig. 1270 with solder ends), is used extensively throughout this layout. Its renewable disc assures drop-tight closure, and it has many other design and construction features which mean economical maintenance and long, trouble-free life. Valves should be packed with solvent resistant packing. Disc type valves should have Teflon discs.

To assure efficiency in the job when planning any major piping installation, consult with accredited piping engineers and contractors, and select your valves from the Jenkins Catalog.

Enlarged diagram and full description of this layout No. 84 free on request to Jenkins Bros., 100 Park Ave., N. Y. 17.

CODE	QUAN.	JENKINS VALVE	SERVICE
A	1 per coil	Fig. 47-U, Bronze Gate	Coil Shutoff
B	1 per coil	Fig. 106-A, Bronze Globe	Regulate Flow Thru Coil
C	1	Fig. 106-A, Bronze Globe	Regulate and Shutoff City Water
D	1	Fig. 92-A, Bronze Swing Check	Prevent Backflow Into City Water Lines
E	1	Fig. 106-A, Bronze Globe	Surge Tank Drain
F	1	Fig. 106-A, Bronze Globe	Surge Tank and Balance System Control
G	2	Fig. 47-U, Bronze Gate	Tube Side of Heat Exchanger Shutoff
H	2	Fig. 47-U, Bronze Gate	Automatic Valve Shutoff
J	1	Fig. 106-A, Bronze Globe	Manual Bypass Control
K	1	Fig. 47-U, Bronze Gate	Shutoff System From Steam Condensate
L	1	Fig. 92-A, Bronze Swing Check	Prevent Steam Condensate Backflow
M	1	Fig. 106-A, Bronze Globe	Trap Test Control
N	1	Fig. 47-U, Bronze Gate	Steam Trap Shutoff
P	1	Fig. 106-A, Bronze Globe	Free Blow and Drain Shell Side of Heat Exchanger Control
R	3	Fig. 743-G, Bronze Needle	Pressure Gage Control
S	1	Fig. 106-A, Bronze Globe	Tube Side of Heat Exchanger Drain
T	1	Fig. 106-A, Bronze Globe	Regulate Pump Discharge and Shutoff Pump
U	1	Fig. 92-A, Bronze Swing Check	Prevent Backflow Into Pump
V	1	Fig. 47-U, Bronze Gate	Pump Shutoff
W	1	Fig. 106-A, Bronze Globe	Pump Drain

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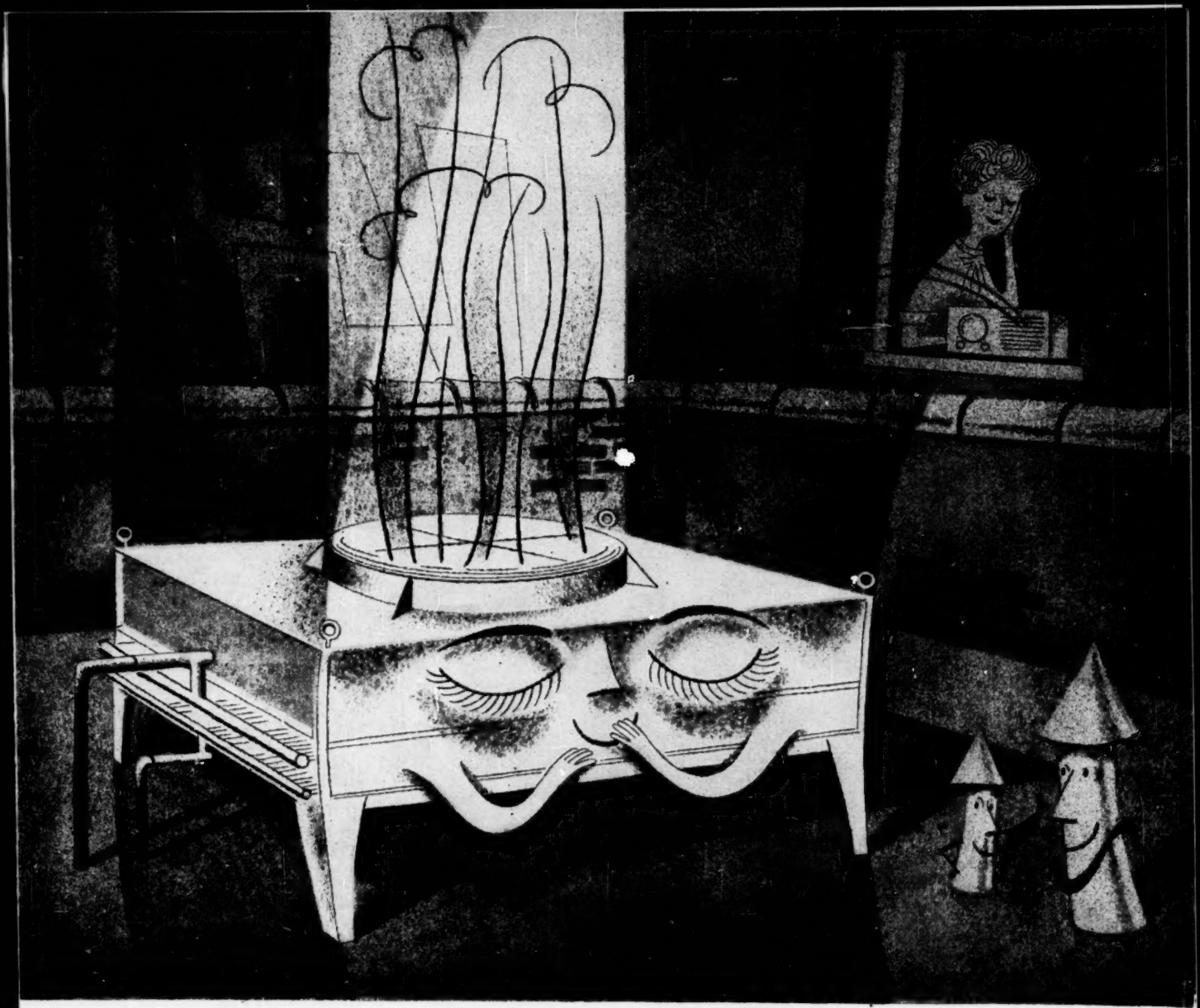

Ever hear of a bashful air-cooled condenser?

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H&M's new ACV Air-Cooled Condenser with vertical air flow hates to be showy. It's so low and so quiet, you hardly know it's there—very appealing to owners, their neighbors, architects and engineers!

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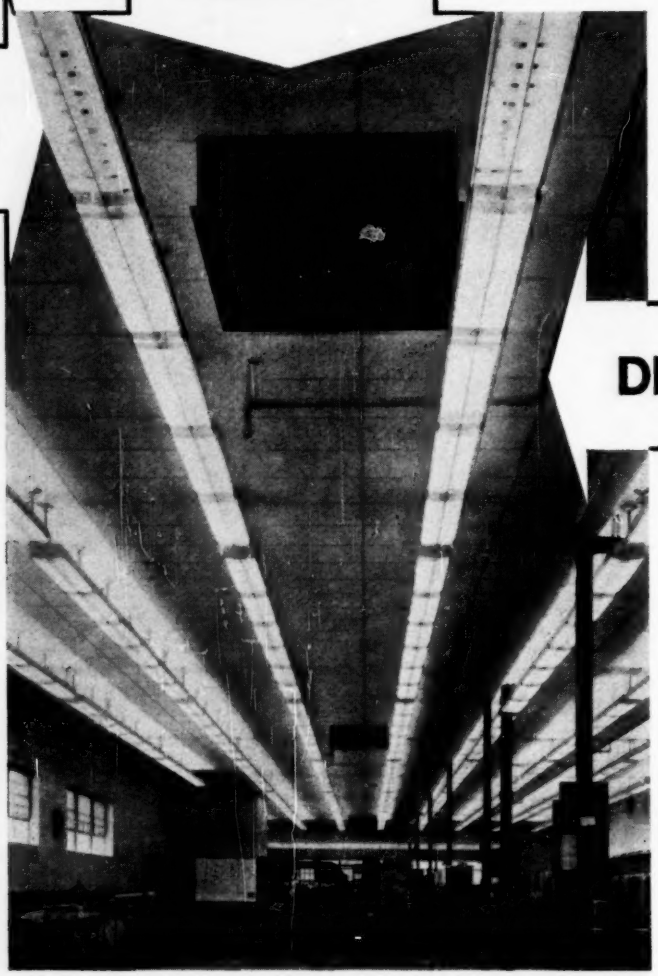
THIS CEILING DIFFUSER



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AIR CONDITIONING HEATING AND VENTILATING

Volume 58, Number 1 **January, 1961**

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FUME CONTROL

Control of Fume from Electric Steel Melting Furnaces **45**
How hoods and gas cleaners solve air pollution problem .....R. T. Pring

HYDRONICS

Residential Snow Melting Systems **51**
Design data for effective, economical systems .....W. S. Harris

REFERENCE SECTION

Storm Sewer Design for Industrial and Office Sites **55**
A guide for the mechanical designer .....W. W. Fannon

DATA SHEET

Foreign Summer Design Temperatures **73**
Data for Africa. Second in a series of three

DETAIL SHEET

Fume Hood With Grease Filters **75**
Details of design and installation.

PACKAGED AIR CONDITIONERS

How to Evaluate Performance at Off-Design Conditions **77**
A new method provides accurate predictions .....H. Suenaga and T. Otaki

AIR CONDITIONING

Design of Water Systems for Air Conditioning **81**
Comparative analysis of two types of flow .....M. J. Wilson

DESIGN SEMINAR

You Can't Buy Conditioning by the Ton **83**
How to specify the conditioner for proper room humidity .....M. A. Ramsey

APPLICATIONS AND INSTALLATIONS

Lead-Asbestos Pads Isolate Cooling Tower Vibrations **89**
How skyscraper tenants are protected .....Al Leichtman

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DEPARTMENTS

High Spots in this Issue **4**
What Readers Say **8**
News of the Month **10**
Plumbing and Piping— L. Blendermann **85**
Annual Index **91**
New Literature **97**
Degree-Days for Nov. **100**
New Equipment and Materials **102**
Briefly Stated News Items .. **124**
Coming Events **131**
Book Reviews **132**
Canadian Degree-Days for Nov. **134**
Index to Advertisers **136**

COVER PHOTO: A new **era of cleaner air has begun for steel workers** with the advent of hoods for electric steel furnaces. Difficult problems in high temperature and materials transport have been solved so that the pall of fume and smoke formerly spewed into factory air is completely controlled. Page 45.

HIGH SPOTS in this issue

STORM SEWER GUIDE: Bill Fannon, a civil engineer with Killam Associates, consulting engineers, has put together this month's Reference Section for mechanical engineers who, for whatever reasons, are called upon to **lay out the storm drainage system** for an industrial plant or office building located in a suburban or rural area. Simplifying assumptions, justified in the case of these relatively modest systems, and step-by-step procedures should prove of very practical worth. Page 55.

SNOW MELTING: Popular opinion is that snow melting, proven so advantageous around banks, stores and other commercial buildings, is a luxury beyond the reach of the home owner. In an article beginning on page 51, Professor Warren S. Harris attempts to disprove this by presenting design, installation and control tips that have been shown at the I-B-R research house to produce **effective and economical snow melting on residential walks and driveways.**

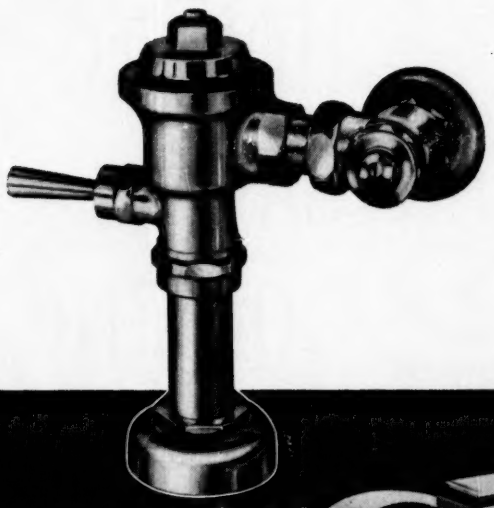
OFF-DESIGN DATA: From Mitsubishi Heavy-Industries, Japan, comes this report on **how to evaluate the performance of an air conditioner at other than design conditions.** To the consultant, the importance of the report is the knowledge that the tests can be made by the manufacturer and that, in time, these data should be generally available. Part I of a two-part article begins on page 77.

WATER SYSTEM DESIGN: **Water for air conditioning systems** can serve various functions and can be handled in a variety of ways. In every case, however, design problems will be encountered, and it is Maurice Wilson's purpose, in his article on page 81, to evaluate some of these water system problems and indicate approaches to their solution.

IGNORANCE OF THE LAW: In air conditioning, even more so than in jurisprudence, ignorance of the law is no excuse. Mel Ramsey, in his second **Specification and Design Seminar,** illustrates the case of an air conditioner that could not possibly handle the space requirements because its specifier was oblivious of the laws of psychrometrics. Page 83.

LEAD FEET: This month's installation story describes the lead-asbestos pads that **isolate cooling tower vibrations** from the occupants of the new 34-story Grolier office tower in New York. The details are included for the benefit of any engineer who wishes to duplicate the system. Page 89.

And in Virginia – A FUTURE OF FAULTLESS SERVICE



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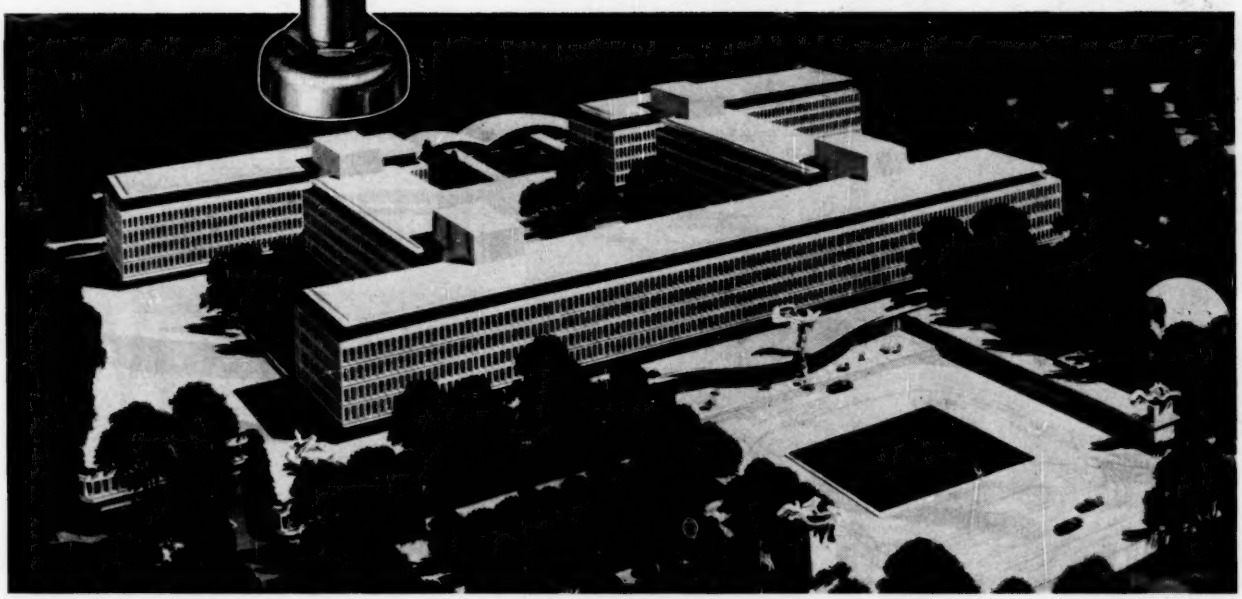
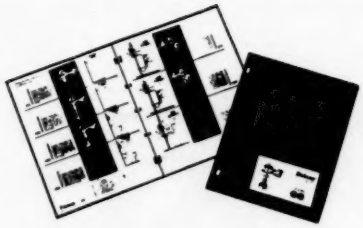


Embodying a design as modern in concept as the agency which it will serve, the new CIA Headquarters Building just outside Washington, D. C. is scheduled for completion in 1961 at an appropriated cost of $46,000,000. Emphasizing architectural line and mass, this DELANY installation is composed of a series of connected blocks with a large interior court. A grassed exterior court leads to the canopied entrance. Over a million square feet of office space will be available for agency activities, and over 700 DELANY diaphragm type Flush Valves will service the sanitary system required for the heavy concentration of personnel. As in all types of public buildings everywhere, DELANY Flush Valves can be relied upon here to provide unflagging performance with minimum attention even under the most severe usage conditions. When maximum standards in flush valves are mandatory, insist on DELANY . . . for a future of faultless service.



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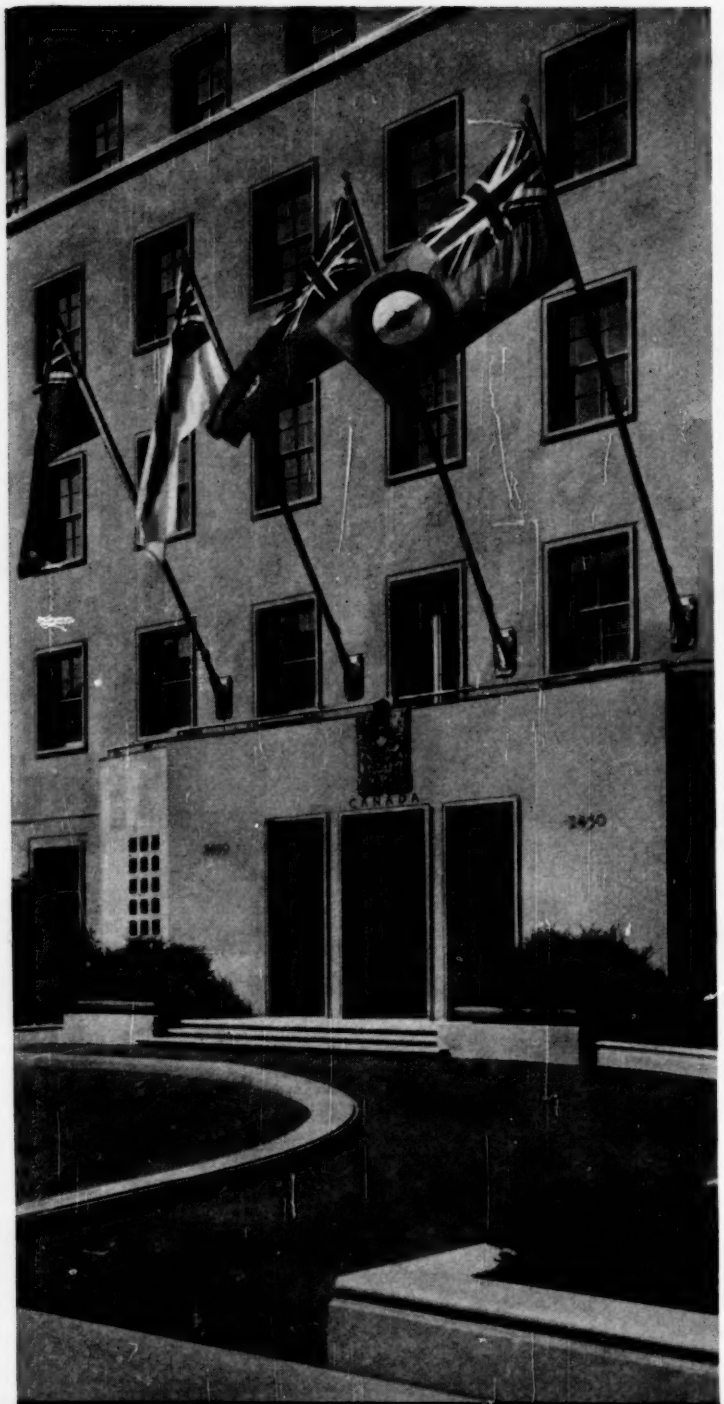


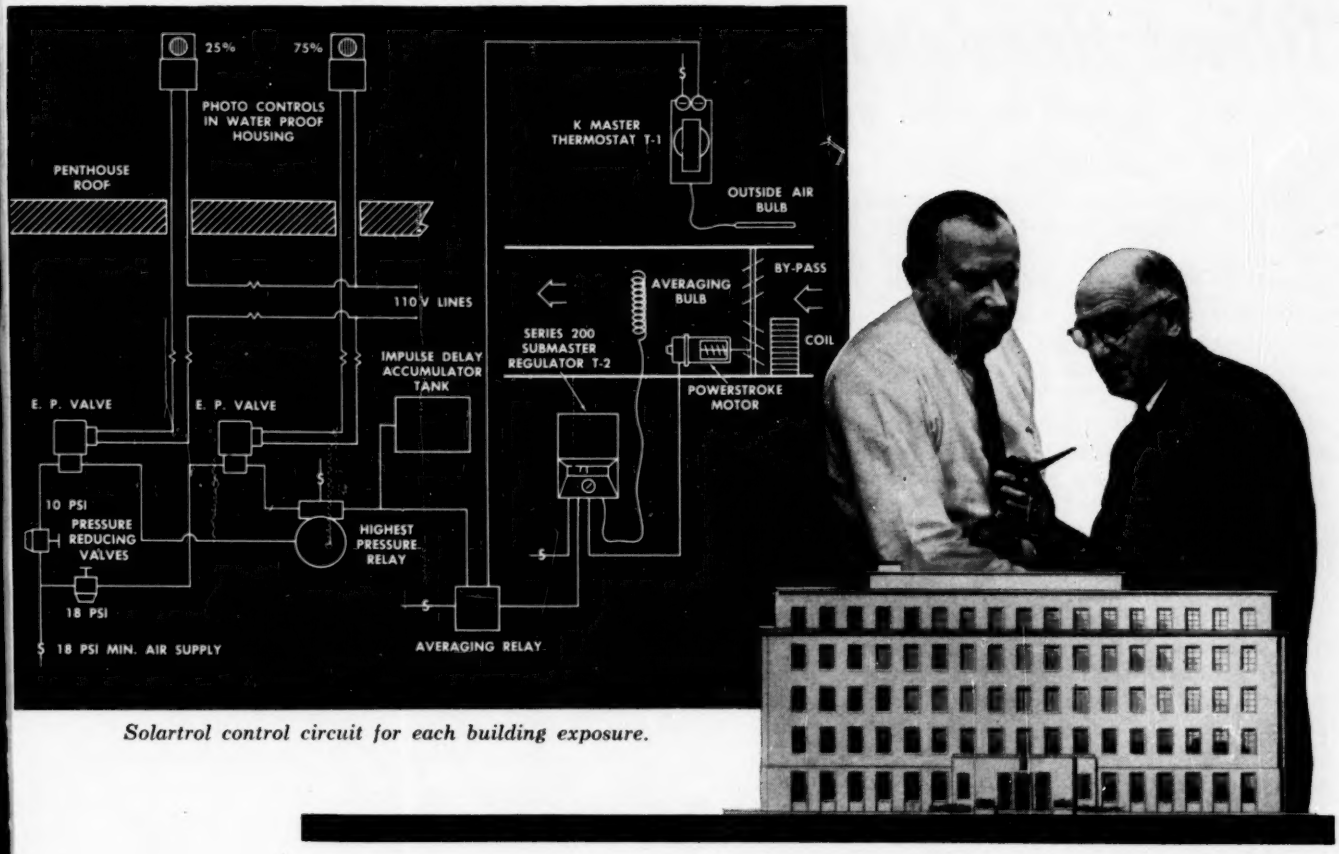
Architects:
Marani, Morris & Allan, Toronto, Ont., Canada
Associated with
Faulkner, Kingsbury & Stenhouse, Washington, D.C.

Consulting Engineer:
Charles S. Leopold, Inc., Philadelphia, Pa.

HOW TO SAVE COOLING DOLLARS WITH SUNPOWER

Consulting Engineer, Charles S. Leopold, confirmed his reputation for imaginative engineering when he put the sun to work in the air conditioning system of the Canadian Joint Staff Building, Washington, D. C. As a result, the occupants enjoy year-round comfort.

The Powers SOLARTOL, an electronic-pneumatic system designed to measure solar intensity and regulate air conditioning systems accordingly, is used to accomplish this.



Solartrol control circuit for each building exposure.

G. Titus Fenn, chief designer, and Charles S. Leopold.

■ ■ ■ ■ ■ ■ ■

HOW IT WORKS—Four pairs of photo-electric cells are mounted on the roof, each pair measuring the solar radiation falling on one side of the building which is oriented 45° from the true north-south. They are connected to submaster thermostats that control conditioned air temperature for each exterior zone in the building. One cell of each pair is set to operate at 25% Solar Gain and the other at 75%.

With no sunlight, an outdoor-air master-thermostat regulates the conditioned air temperature. As outside temperature rises from 78° to 95°, the zone air supply controls reset through a range of 68° to 63°.

With 50% Solar Intensity, the thermostat controls for that particular building zone are adjusted to operate at a 5° lower temperature range — 63° to 58° — to compensate for the additional heat of the sun.

With 100% Solar Intensity, the zone air supply controls are adjusted to operate at a still lower temperature range — 59° to 54°.

By varying the temperature of the air in the zone duct according to solar intensity as well as outdoor temperature, the final room controls operate more accurately. Equally important is a definite economy of refrigeration.

Powers controls systems and "Imaginative Engineering" — are establishing new highs in comfort conditioning. Case histories are available — ask for them.

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What Readers Say:

BUDGET DATA FOR OFFICE BUILDINGS — COMMENTS AND A REPLY

EDITOR, AIR CONDITIONING, HEATING AND VENTILATING

Mr. M. J. Wilson should be congratulated on a very interesting and informative article, "Air Conditioning Budget Price Data for Office Buildings," which was published in your November, 1960 issue.

However, I feel that it lacks some very pertinent information. It should be pointed out that the limit of performance or production of comfort is different for each system cited by Mr. Wilson. These limits follow, in general, the costs shown with poorest performance having the lowest cost. Therefore, it is impossible to make direct comparisons of any two systems discussed in Mr. Wilson's article.

Furthermore, costs of systems are indicated by lines in Mr. Wilson's article. We can only assume that these are meant to be averages. However, each type of system has its own limits of flexibility, again varying, in general, with cost. It might be better to show costs by using a series of bands of varying widths to indicate the general variations in costs and flexibility for each type of system.

For example, records of many dual duct installations show that a band indicating the cost of dual duct systems is extremely wide as shown on the accompanying chart where it has been superimposed on Mr. Wilson's curves, using Mr. Wilson's dual duct cost curve for the upper limit. It should be pointed out that a small number of dual duct installations on record will fall below or above the band shown. Such extreme of costs are caused by special design criteria, structural or architectural features or other factors.

A detailed discussion of installed costs on dual duct systems was presented by N. S. Shataloff in his article "High Velocity Dual Duct Systems for Multi-Zone Installations" published in AIR CONDITIONING, HEATING AND VENTILATING, April and May, 1958, and "Comparative Costs of Dual Duct Air Conditioning Systems" published in your June, 1960 issue.

It is also regrettable that Mr. Wilson's article omits discussion of costs of dual duct systems in existing buildings. Experience shows it is in existing buildings that the great flexibility of this system allows marked cost and functional advantages over less flexible systems.

J. W. Kreuttner

Buensod-Stacey Corp.
New York, N. Y.

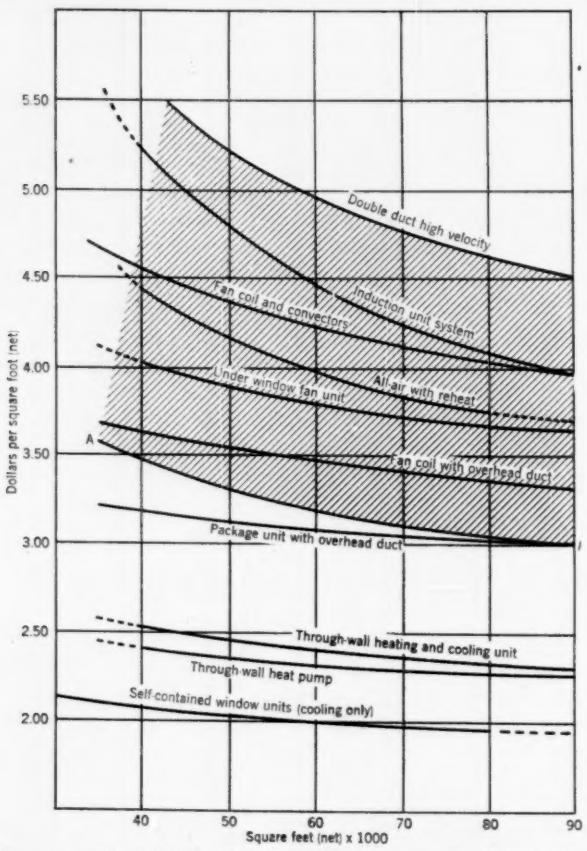

Figure 1 of article by M. J. Wilson. Curve *A-A* and the cross-hatched area are added to show range of installed costs for high velocity dual duct systems.

A copy of the letter written by J. W. Kreuttner was sent to Mr. Wilson for his comments. The author's reply follows:

EDITOR, AIR CONDITIONING, HEATING AND VENTILATING

A functional evaluation of the several systems included in the article entitled Air Conditioning Budget Price Data for Office Buildings will show the great difference in the ability of these systems to maintain within well defined limits, those factors which affect our comfort. Such an evaluation was presented in ACH&V, October, 1960, entitled Selecting Air Conditioning Systems for Specific Applications. There is also an appreciable difference in first cost, as shown by the curves—a fact that has been well established.

It is the responsibility of the design engineer to select for a specific project, the type of system which gives the greatest benefits per dollar of overall cost. The selection depends on the type and quality of building. Certainly, for Class *A* commercial office buildings and owner-occupied buildings, the selection by the engineers in the past indicates a preference for quality air conditioning such as may be obtained with the "All-Air" and "Air-Water" type systems.

One may conclude, therefore, that for certain application, these particular systems do give greater benefit per dollar of owning and operating cost.

M. J. Wilson
Market Promotion Specialist

Carrier Corp.
Syracuse, N. Y.

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NEWS OF THE MONTH

TRAINING IN HIGH SCHOOLS IS GOAL OF ARI COMMITTEE

With a pilot operation already in effect, the Training Committee of Unitary Air-Conditioner Section, Air-Conditioning and Refrigeration Institute (ARI), hopes to expand its training program into a dozen or more public school systems by the beginning of the 1961-62 school year, with the ultimate goal of producing a "package" training course in air-conditioning and refrigeration service and maintenance usable in high schools and vocational schools throughout the country where a need exists for the training of installation and service mechanics.

This was the gist of a report made to the Unitary Section at its meeting in Hollywood Beach by A. E. Meling, chairman of the Training Committee named last Spring to develop programs aimed at increasing the supply of qualified service and installation personnel. A full-time man will probably be assigned to handle the training program as soon as it has been developed to the point of offering it to schools throughout the country.

Pilot Operation in Syracuse

Mr. Meling, director of service, Carrier Air-Conditioning Company, reported that the pilot operation already operating is in Central High School, Syracuse, where "we now have two sample classes running at night and one during the day."

In addition to high school students attending the day class, 56 men from the offices and shops of mechanical contractors, consulting engineers, dealers, distributors, and manufacturers in the Syracuse area are attending the two night classes. Commenting on this, Mr. Meling said:

"Both day and night courses are important. The night course permits the training of personnel in one school year. The day courses are slower, usually starting in the second year of high school and requiring three years to turn out trained personnel."

R. K. Serfass

Columbus May Get Program

A second pilot operation may be started in a Columbus, Ohio, high school with the beginning of the second semester, spearheaded by Harry C. Gurney, and Coit B. Lytton. Mr. Gurney, a member of the Training Committee is General Sales Manager of Janitrol Heating and Air-Conditioning Division, Midland-Ross Corporation, and President of the National Warm Air Heating and Air Conditioning Association. Mr. Lytton is Sales Manager for Lennox Industries Incorporated, and former chairman of the Unitary Section. By the end of the school year, it was reported "we hope to be in a position to spell out all the details of what has to be known, curriculum, material, lab specifications, equipment, etc., to carry on this kind of teaching in a public high school.

The "package" which is being developed as a result of these and subsequent prototype classes probably will include curriculum material for both day and extension course students, together with a set of instructions as to how distributors representing the ARI member-manufacturers would go about introducing similar courses in local high schools, Mr. Meling said.

In addition to the development of textbooks, curriculum, and other preliminaries, Mr. Meling pointed out that a part of the job, after the program is developed, will include promotional work with guidance counselors to encourage them to advise more students to go to technical high schools to study refrigeration and air-conditioning; encouragement of distributors and

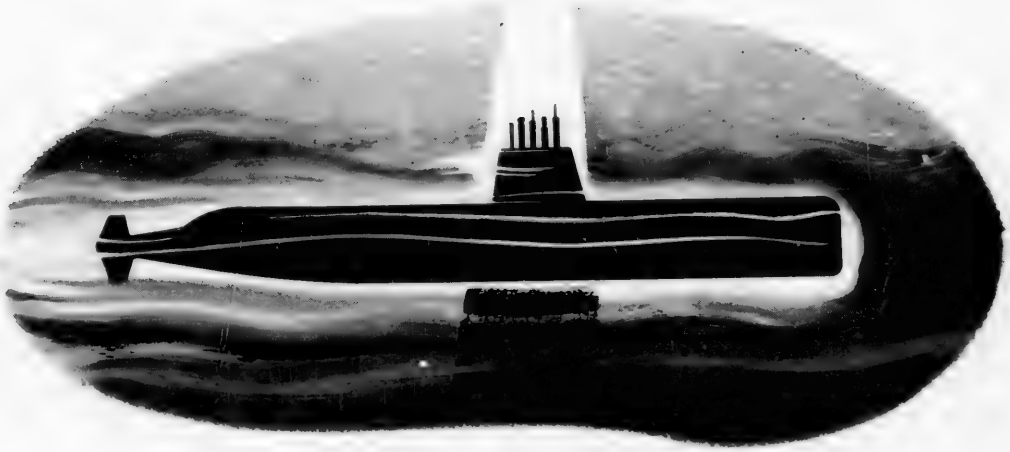
(Continued on page 12)

R. K. SERFASS NEW ARI PRESIDENT; CERTIFICATION PROGRAM TO EXPAND

R. K. Serfass, manager of Westinghouse Electric Corporation's Air-Conditioning Division at Staunton, Va., succeeds Rudolph G. Berg, vice-president of Copeland Refrigeration Corp., Sidney, Ohio, as chief executive officer of Air-Conditioning and Refrigeration Institute, trade association of the industry, Washington, D. C.

At the same time, ARI announces that its Certification Program, which includes only unitary air conditioners as present, may be expanded in the near future. Unitary heat pumps probably will be included in 1961. One of the Institute's heat transfer sub-sections is planning certification programs for room fan-coil air conditioners and for room air-induction units. The Water Cooler Section is committed to a program for drinking-water coolers.

In addition, revisions of standards looking toward possible inauguration of certification programs are under way in the Centrifugal Liquid-Chilling Packages Section, Mobile Refrigeration Section, Reciprocating Liquid-Chilling Packages Section, and Valves, Driers, Fittings, and Accessories Section. The Reciprocating Compressor and Condensing Units Section is examining the problems involved in, and the possibilities of, a certification program covering at least some portion of its products.



how activated charcoal solved a no. 1 problem of our atomic subs ...fresh air

The scarcest commodity aboard our atomic subs is not fisionable material—it's plain old fresh air.

Take a hundred men, hermetically seal them in a huge steel tube, then submerge the tube for days at a time.

Call the result the "Nautilus" or the "Triton" and you have an idea of the problem of building submarines to utilize the power potential of nuclear energy. They can literally stay submerged as long as the crews can stand the confinement.

Even without other contamination, just breathing would soon make the air within the tube unbearable. Then add body odors, a kitchen, a lot of complex machinery, areas where smoking is permitted, lavatories and waste tanks and you have a real problem.

To solve the problem, the Navy turned to one of the oldest and most effective methods of air purification—adsorption by Activated Charcoal.

Barnebey-Cheney Activated Charcoal filters are a standard part of the subs' air conditioning systems. Others are installed on the waste tank vents, still others in the lavatories. Odors and contaminants are trapped and held in the Barnebey-Cheney Activated Charcoal.

The same principle can be applied to heating, ventilating and cooling of homes, offices, schools, hospitals or public buildings where fresh, healthful, odor-free air is essential. Barnebey-Cheney builds a complete line of air purifiers for applications of any size, from disposable filters for window coolers to central system purifiers for the huge new Dallas Auditorium.

As in the atomic submarines, *true* air conditioning *must* include *air purification*. Activated Charcoal is the proven, practical means of accomplishing it. To learn more, write for Bulletin T352, Barnebey-Cheney, Columbus 19, Ohio.

Barnebey Cheney

HONORED FOR ADVERTISEMENTS

Hueston M. Smith (left) St. Louis, national president of the Consulting Engineers Council, presented his organization's first annual Merit Award to the Minneapolis-Honeywell Regulator Co., for their current advertising campaign which "highlights the aims and principles of the consulting engineer and encourages the use of his skill." Here, R. H. Jacobs, Minneapolis, advertising coordinator for the firm's Commercial division, accepts the certificate for award which was made at CEC's semi-annual board of directors meeting in Pittsburgh.

ARI TRAINING COMMITTEE

(Continued from page 10)

service organizations in various cities to cooperate in working with school officials to get the program established, and the employment of qualified instructors, which usually will be paid by the school system.

Emphasizing the need for the ARI Training Program, Chairman Meling reiterated his statement made at the time the Committee was appointed: "If we could get the men to install and service our equipment, we could double our volume. We need a training program." To this he added: "Unless twice as many people are trained during the next decade as are available now, the expansion of this industry will be seriously hampered."

PREASSEMBLED COMPONENTS CUT ON-SITE CONSTRUCTION COSTS

The building industry took a close and critical look at the use of preassembled components to cut down on-site construction and fibrication. In a full-scale conference on the subject conducted by the Building Research Institute of the National Academy of Sciences-National Research Council in Washington, D. C.

Following the expression of viewpoints by various segments of the industry, the BRI audience heard five speakers discuss the principles underlying preassembled component construction and then proceeded to examine five case studies of structural components in use.

All-Metal

Among these was the all-metal building system devised by American Bridge Division, U.S. Steel Corp. This system utilizes columns prefabricated from seamless steel tubing, exterior walls are steel curtain wall panels. Sash and door panels are preassembled commercial panels interchangeable with solid panels and containing steel aluminum or stainless steel sash. Interior walls are steel partitions. Completed buildings were said to have performed well. They have remained weathertight through all extremes in climates varying from nothern New England to southern Texas. Experience indicates that the high quality metal buildings are not economical for very small structures. The exact break-even point varies with the type of structure and seems to fall between 5,000 and 12,000 sq ft. The advantages increase as the size increases, as long as special items do not become too numerous. Maintenance of the buildings proper is very low. Damage from vandalism, accident or disaster can be readily repaired at reasonable costs.

Underground School

In the session conducted by the BRI Research Committee, a number of interesting new building research projects were described.

REFRIGERATION GROWTH CREDITED TO CONTRACTOR CERTIFICATION

Stimulation of growth in the realm of increased employment and business contracts in the air conditioning and refrigeration industry throughout Los Angeles and Orange Counties, California, has recently been credited to the promotion program of the Certified Refrigeration and Air Conditioning Foundation (CRAC).

An analysis of this growth pattern was made public in a special report by L. P. Jacobsen, chairman of the Foundation. In his report, Mr. Jacobsen noted that under the program more than $900,000 in added gross income has been generated for the contractors in the area during the first eight months of 1960. The added income does not include profits for refrigeration and air conditioning equipment whether on service work or new construction.

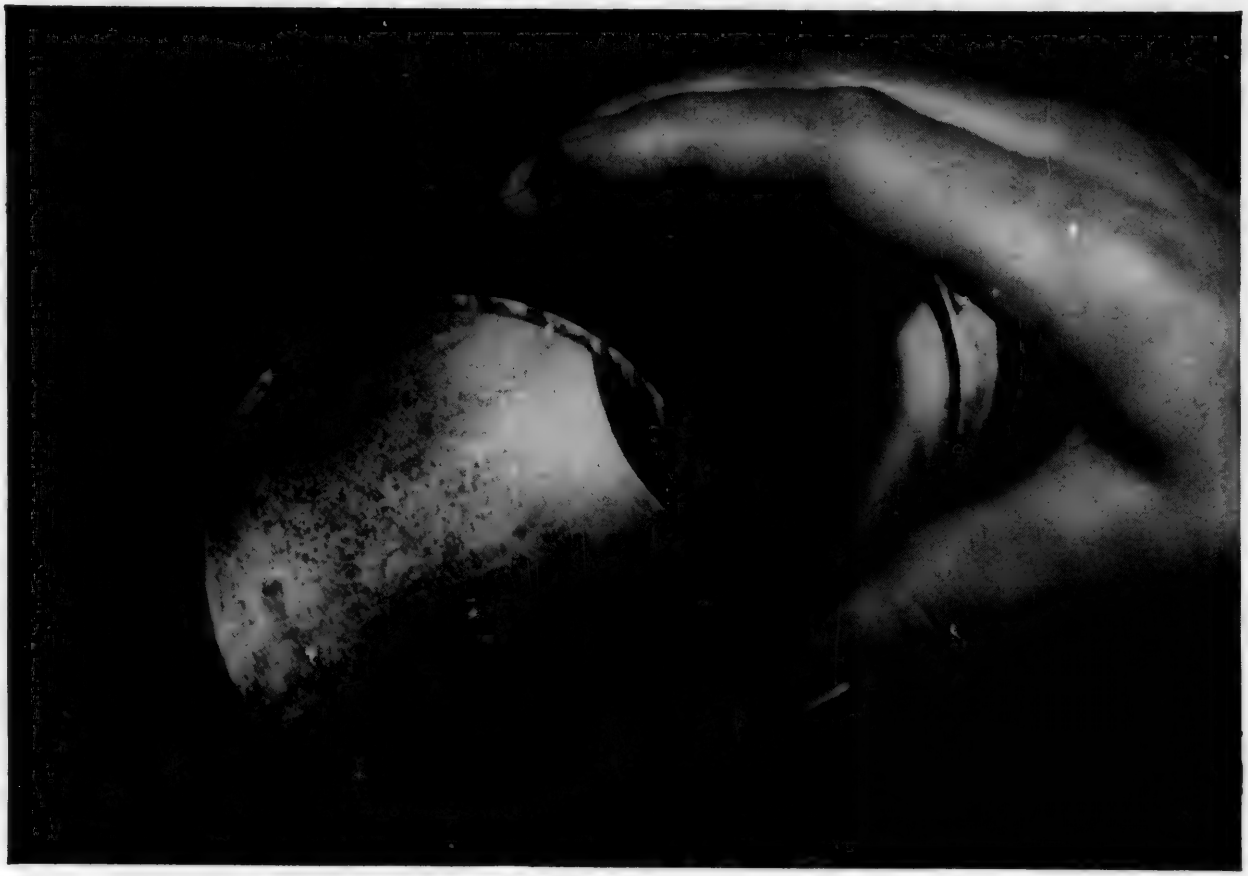
Wages Also Rise

Meanwhile, through the promotion program, union members employed in the refrigeration and air conditioning industry benefited by nearly a half of a million dollars in new and additional wages during the same period.

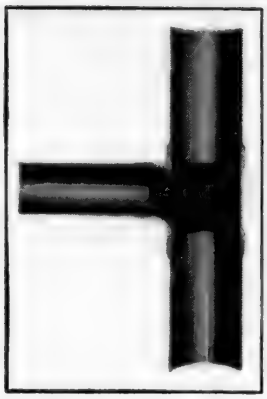
CRAC operates under the Joint Journeymen & Apprentice Training Committee, composed of labor and those Southern California contractors who meet certain standards of employee education and training.

With only minor modifications in designing the mechanical and structural systems of schools, a greater degree of fallout protection can be afforded, contended Milo D. Folley, partner, Sargent-Webster-Crenshaw & Folley, Architects (Syracuse, N. Y.) "An underground school," he said, "can be both functional and pleasant, but, above all, economical. Its interior can be colorful and spacious with atmosphere controlled for best teaching conditions."

(Turn to page 14)



Unretouched photo of 3" dia. copper tube removed after 13 years' service in a soil line.



Anaconda drainage fittings are designed to match Anaconda tube for fast, easy solder connections.

WASTES FLOW FREELY IN COPPER DRAINAGE SYSTEMS AND YOU SAVE MONEY. Compare the condition on the inside of this copper tube with what you might expect to find in ordinary piping after 13 years in service. Rust-caused troubles such as reduced flow or stoppages do not occur inside copper drainage lines. That is why many plumbing codes allow the use of 3" diameter copper tube for soil line and vent. Material costs are reduced and, because a 3" copper tube stack with fittings fits inside a standard 4" partition, the need for expensive, space-consuming plumbing walls is eliminated. Save time, effort, and money—install the modern drainage system with Anaconda copper tube and fittings. For information, write: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

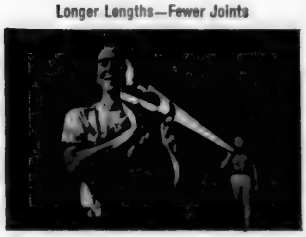
6001L

ANACONDA®

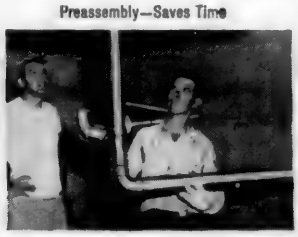
COPPER TUBE AND FITTINGS for soil, waste and vent lines

Available through plumbing wholesalers. Anaconda American Brass Company

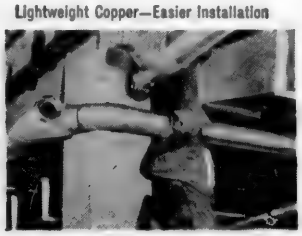
Longer Lengths—Fewer Joints



Preassembly—Saves Time



Lightweight Copper—Easier Installation



Compact Connections—Save Space

Domination of Compressor Market by Hermetic Units Documented

During the past fifteen postwar years, the continued development and application of hermetic compressors and condensing units has grown to the point where they practically dominate our industry, John J. Floreth, York Div., Borg-Warner Corporation, said.

Speaking before the Refrigeration and Air Conditioning Contractors Association 15th Annual National Convention in Miami, Fla., the York vice-president and director of services based his analysis on ARI and Department of Commerce data.

Industry sales of compressor units (Fig. 1) grew from slightly over 2 million units in 1954 to over 4 million in 1959. Industry-reported sales of approximately 3.4 million hermetic units in 1959 represented almost 84% of total unit sales. Today in our industry, Mr. Floreth pointed out, room air conditioning units, residential units and self-contained commercial air conditioners represent over half of the total number of compressors applied each year and are almost entirely of the hermetic type.

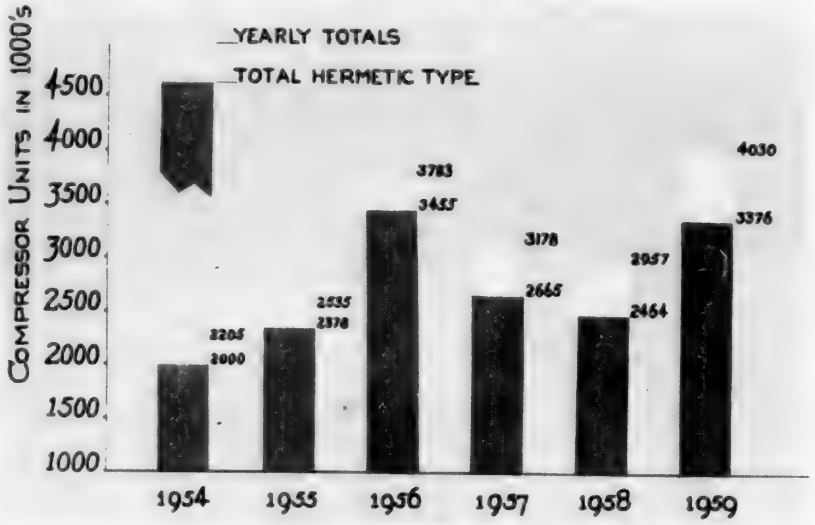


Fig. 1. Sales of compressor units (all sizes).

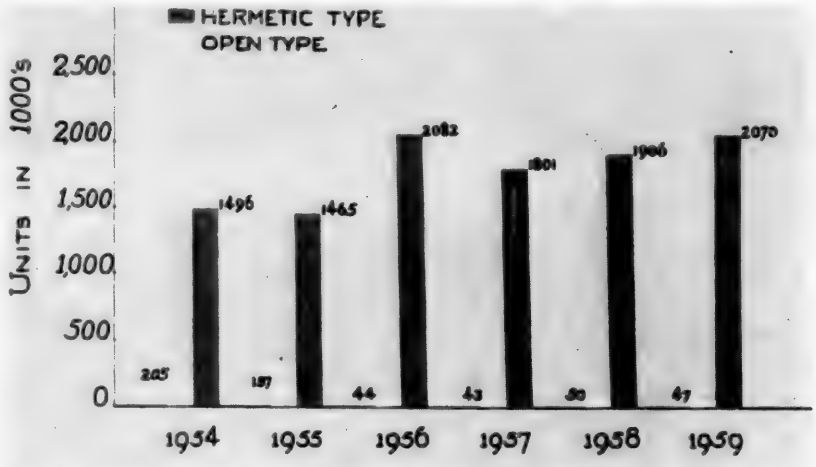


Fig. 2. Sales of room air conditioners, residential units, and self-contained units vs. open-type compressor systems of all sizes.

Open-Type Units Decline

Mr. Floreth contrasted the sale of hermetic and open-type reciprocating compressors during the same years, 1954-9 (Fig. 2). While the sale of air conditioning units using hermetic type compressors has gradually climbed from 1.5 to over 2 million during the past six years, the total sale of open-type compressor units, omitting the automotive air conditioning compressors, is almost insignificant by comparison and has declined to an average level of approximately 50,000 units per year.

A comparison of manufacturers' shipments of condensing units below 20-hp size, (Fig. 3) where a comparison of open and hermetic types would appear to be more accurately determined, Mr. Floreth said, shows that hermetic units have gradually increased from 497,000 in 1954 to approximately 613,000 in 1959, while the open type

(Continued on page 122)

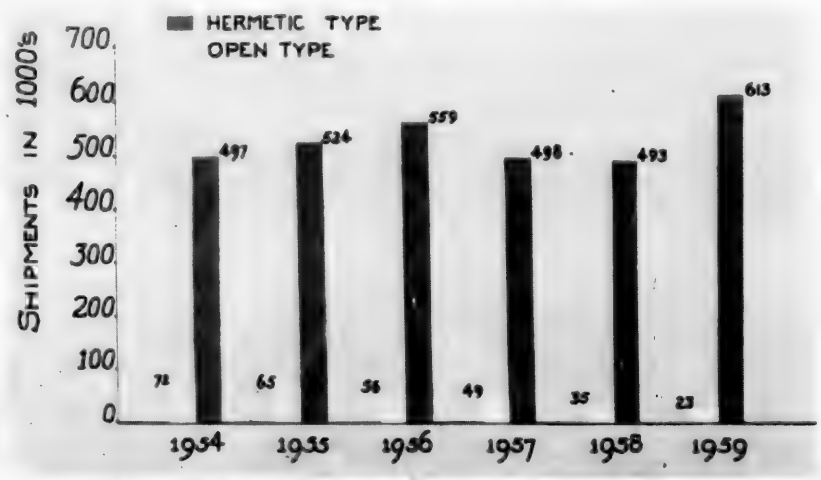
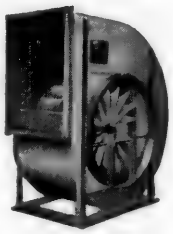


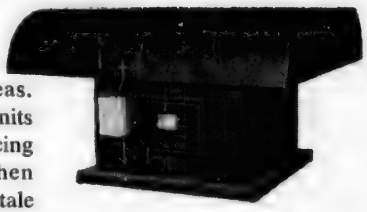
Fig. 3. Manufacturers' shipments of condensing units (below 20 hp).

'BUFFALO' AIR HANDLING EQUIPMENT

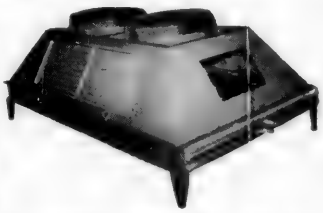
VENTILATING FANS — TYPES "BL" AND "BLH": Quiet, efficient, non-overloading performance. Give completely stable performance from free delivery to shut-off. "BL" designed for moderate pressures (Classes I-II). "BLH" designed for high pressures (Classes III-IV). To minimize turbulence, both types feature smoothly-curved inlet bell with directional guide vanes, wheel with full curvature shroud matching the inlet bell and streamlined, wheel-contoured housing. "BLH" has divergent outlet, further reducing turbulence. Capacities: 1,000 to 500,000 cfm. *Write for Bulletins F-104 and F-201.*



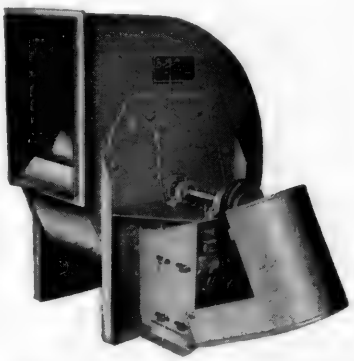
POWER ROOF VENTILATORS: High-efficiency Style "H" Sky-Vents ventilate, heat and/or cool large open plant areas. Fewer large capacity units are needed, thus reducing installation costs. When used for exhausting, stale air can be replaced, heated and/or cooled by 'Buffalo' Makeup Air Units. Sky-Vents are easily-installed, weatherproof "packages." Extensive or expensive duct work is held to a minimum. Capacities: 1,000 to 250,000 cfm. *Send for Bulletin FM-2345.*



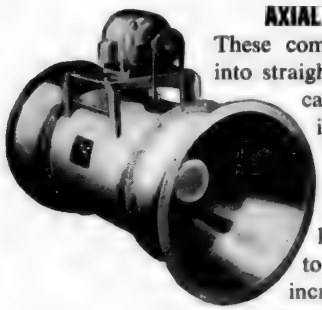
AIR COOLED CONDENSERS: Provide highly efficient, economical, trouble-free cooling for air conditioning, steam condensing, jacket water cooling and many other applications. These easily-installed units have vertical discharge, low silhouette. Standard Capacities: 7½ to 100 tons based on 120° condensing temp., 40° suction, 100° ambient. Larger sizes on special order. *Write us for complete facts.*



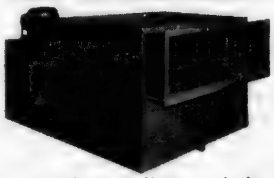
BELTED VENT SETS: Easy-to-install, economical-to-operate "packaged" ventilating fans. Provide quiet, efficient non-overloading operation. Flexible units, ideal for smaller plants or separate areas of large plants. Capacity can be increased after installation to handle expanding ventilation needs. Capacities: 500 to 20,000 cfm. *Send for Bulletin FMB-235.*



AXIAL FLOW VENTILATING FANS: These compact, lightweight units fit into straight, round duct runs. Applications: ventilation, exhausting, system boosting, draft and circulation. Very quiet, efficient and non-overloading. Vaneaxial fans have guide vanes at outlet, to convert swirling air into increased forward thrust. Tubeaxial models (without vanes) also available. May be ordered in various constructions to suit applications. Direct connected drive, or V-belt drive with motor out of air stream. Capacities: 2,000 to 65,000 cfm. *Write for Bulletin 3720-A.*



ZONE CONTROL CABINETS: Ideal for use where a single unit is desired to provide varying degrees of conditioned air for each of several zones. Cooled and heated air is mixed in correct proportions to suit needs of each area. No need for separate reheat coils and their controls. These compact units are quiet, efficient, economical. Adaptable to any combination of heating, cooling and/or dehumidifying. *Write for full details.*



Ventilating Fans (centrifugal, axial flow and propeller), Mechanical Draft Fans, Blowers, Exhausters, Air Washers, Drying Equipment, Air Conditioning and/or Cleaning Equipment, Unit Heaters, Air Preheaters, Packaged Power Roof Ventilators, Makeup Air Units, Spray Nozzles. 'Buffalo' is ready to work with you on any air problem you may have. Call the 'Buffalo' Engineering Representative in your nearest principal city, or write for Bulletins or information.

"Buffalo"

AIR HANDLING DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

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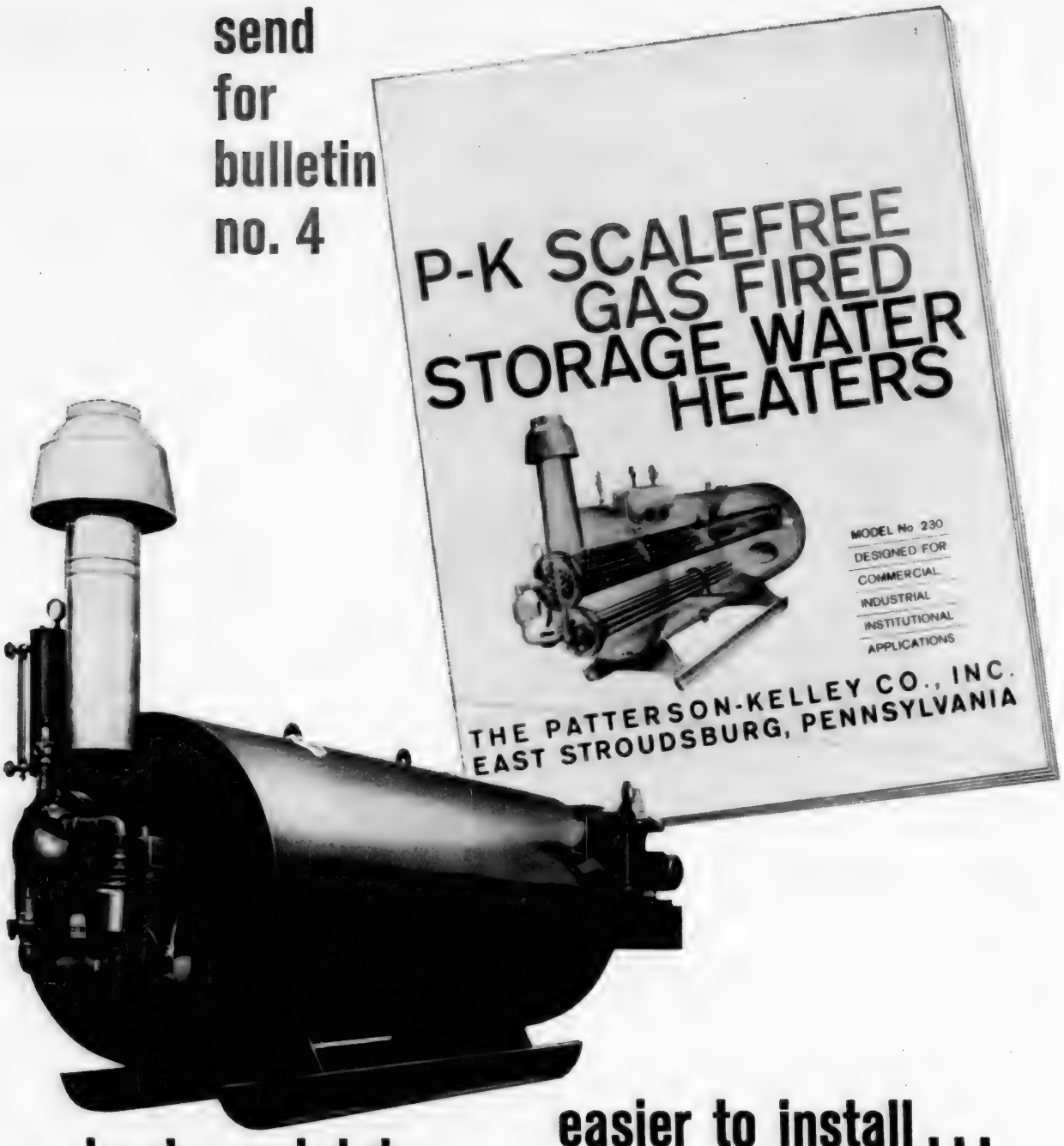

easier to maintain

easier to install . . .

Striking new economies are now available for commercial, industrial and institutional buildings with P-K's SCALEFREE 230, the first indirect gas fired storage water heater • **Installation.** A complete and automatic package, P-K's SCALEFREE 230 can be skidded into place, hooked up and checked out quickly. There is no complicated piping or electrical work to run up costs. No stack is needed for extra draft. No foundation is necessary. Factory insulation (optional, as illustrated) further reduces costs and avoids the complications of on-the-site insulating. • **Maintenance.** P-K'S SCALEFREE 230 offers new freedom from trouble. It won't scale—and retains its rated efficiency—because heat transfer occurs below the temperature at which scaling minerals precipitate. Linings of Pre-Krete® or copper keep the storage section free of rust and corrosion regardless of water conditions. • P-K'S SCALEFREE 230 is available in storage capacities from 250 to 4,000 gallons; recovery sections from 390,000 to 2,215,000 BTU. Bulletin No. 4 gives complete engineering and performance data.

Address your request to: The Patterson Kelley Co., Inc., 101 Morgan Avenue, East Stroudsburg, Pennsylvania.

Patterson Kelley

Water Heater Division

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DUAL DUCT COMPATIBILITY

Adding air conditioning to an existing building need not be a weighty problem. The radiation system generally inherent to this type of structure can simply and economically be augmented by Buensod Dual Duct. Dual Duct is 100% compatible with existing systems. Zones supplied by the old system are given additive ventilation as required and are cooled in warm weather. Newly created zones are completely conditioned for year-'round comfort.

The Dual Duct system is basically a simple one. Hot and cold air is carried at high velocity in separate ducts. Buensod air mixing units in the various zones quietly deliver just the right amount of conditioned air. And exclusive Automatic Volume Control maintains constant air volume regardless of static pressure variation so the system can never be thrown out of balance. Specify Buensod for your next renovation and see how Dual Duct compatibility simplifies your job.

BUENSOD DUAL DUCT

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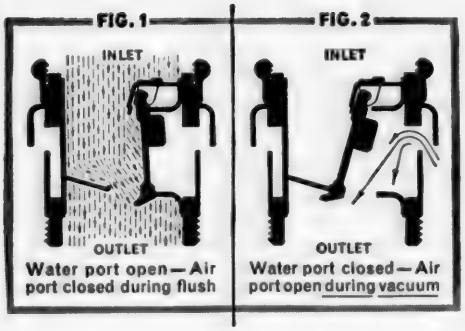
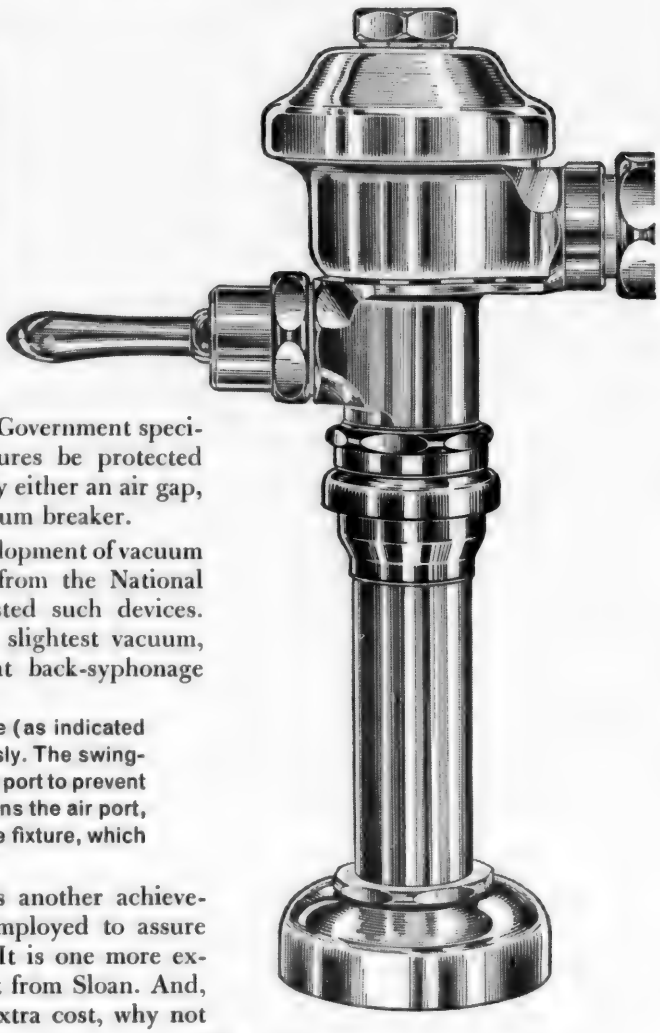
BUENSOD-STACEY

A subsidiary of Aeronca Manufacturing Corporation

You pay no more for unequalled SLOAN quality...

Double PROTECTION with SLOAN Vacuum Breakers



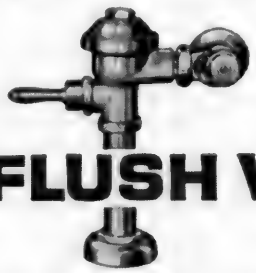


Municipal plumbing codes as well as U. S. Government specifications stipulate that all plumbing fixtures be protected against the possibility of back-syphonage by either an air gap, where practicable, or by an approved vacuum breaker.

Sloan Valve Company pioneered the development of vacuum breakers and was first to gain approval from the National Plumbing Laboratory which formerly tested such devices. Sloan Vacuum Breakers, sensitive to the slightest vacuum, incorporate double protection to prevent back-syphonage as follows:

> When a vacuum occurs in the supply line (as indicated in Fig. 2), two things happen simultaneously. The swinging check instantly seats against the water port to prevent back-syphonage; and, as it swings, it opens the air port, admitting full atmospheric pressure to the fixture, which again prevents back-syphonage.

This superior vacuum breaker represents another achievement of Sloan engineering, constantly employed to assure outstanding products through research. It is one more example of that bonus of quality you expect from Sloan. And, since you can have Sloan quality at no extra cost, why not make sure you get it.



SLOAN FLUSH VALVES

SLOAN VALVE COMPANY • 4300 WEST LAKE STREET • CHICAGO 24, ILLINOIS

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BUILT-IN QUALITY
BUILT-IN PERFORMANCE
with

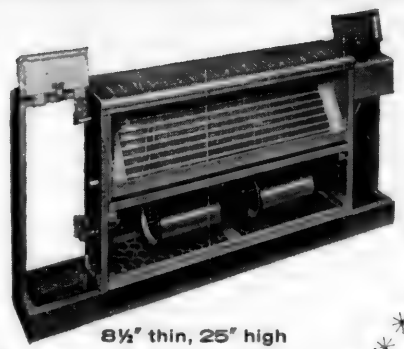
individual room

NOW 4
MODELS

220 to 1240 CFM

Extra large piping compartments, 8½" thin design, complete slide-out fan deck assembly, motor disconnect plug, field reversible coils, full rated capacity and day-to-day quiet, efficient operation . . . these are but a few of the many reasons why so many engineers, contractors and building operators are specifying and installing McQuay thin-line design, individual room Seasonmakers.

Availability in four types and seven sizes and faster, easier installation make them preferred for apartments, hotels, motels, offices or any installation utilizing a central station heating and cooling system. Hideaway and ceiling models range from 220 to 640 cfm. Floor and basic models from 220 to 1240 cfm. Contact your local McQuay representative, or write McQuay, Inc., 1619 Broadway Street N. E., Minneapolis 13, Minnesota for detailed specifications.



8½" thin, 25" high

McQUAY Means Quality

McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION

Complete responsibility centered in one specialized organization!

Undivided responsibility for *all* phases of a temperature control installation — from coordinated planning to future service — is the key to lasting owner satisfaction. Each Johnson System, small or large, is furnished on this basis, for 75 years' experience has proved it to be the *only* way to assure the kind of lifetime efficiency and operational economy an owner expects from his control system.

When they invest in a Johnson Pneumatic Control System, your clients are investing in years of reliable performance, something hardly to be expected from scattered sources whose responsibility ends with the sale. With air conditioning, heating, and ventilating systems becoming increasingly complex, now it is even more important that responsibility for the control system be centered in one organization.

Johnson's way of doing business, as demonstrated in leading buildings everywhere, enables your clients to enjoy the very finest standards of indoor climate control at the lowest possible lifetime cost. Complete sales, engineering, installation, and service facilities are available from over 105 direct branch offices. Johnson Service Company, Milwaukee 1, Wisconsin.

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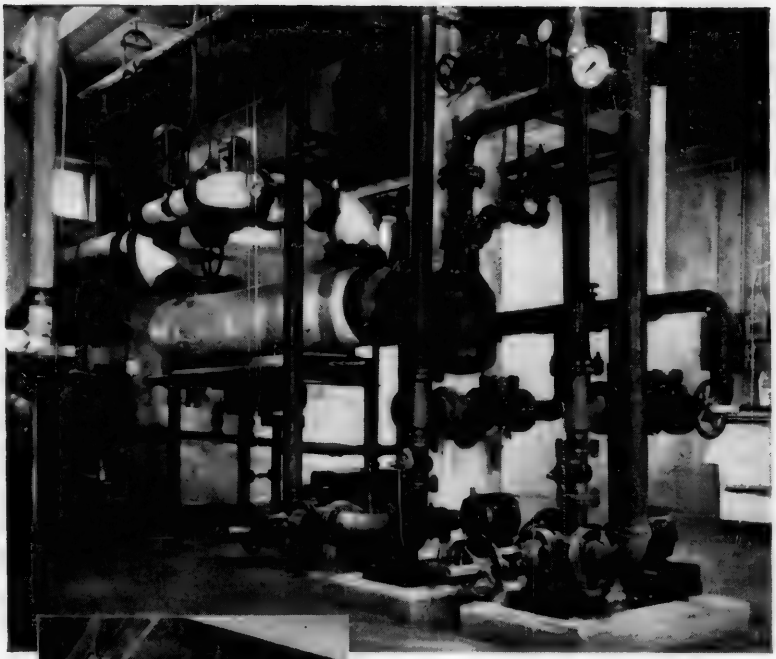
PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

FOR ECONOMICALLY HEATING WATER WITH STEAM

TYPE "SU" HEAT EXCHANGER



▲ Type "SU" Heat Exchanger used to heat convectors for faculty rooms, Loyola Academy, Chicago

◀ "SU" installed to heat swimming pool shower water, Loyola Academy

▶ This "SU" is used to furnish supplemental heat to a warehouse and shipping room area at Avon Products Inc., Morton Grove, Ill.

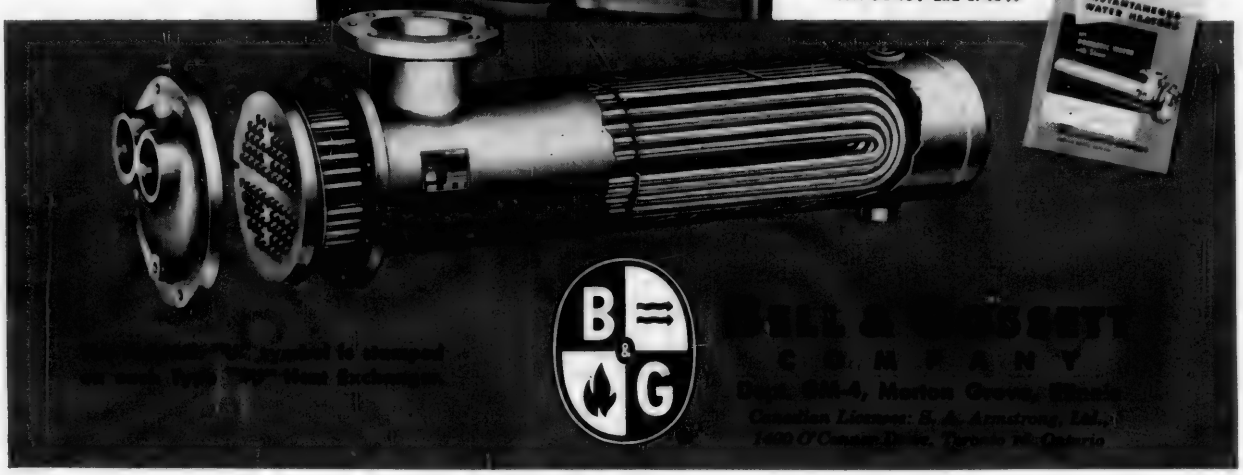
B&G Type "SU" Instantaneous Heat Exchangers are designed to heat water or other liquids with steam and can be connected to any steam boiler or system.

An "SU" provides an efficient low cost method of heating water for apartment buildings, hotels, hospitals, schools, industrial and processing plants. Comparatively small units produce large volumes of hot water—no storage tank needed.

In buildings where steam is required for process use, the advantages of a forced hot water system can be obtained by installing an "SU" Heat Exchanger instead of an extra boiler. These heaters also have many applications in vertically zoning large hot water heating installations to avoid high static heads.

With each B&G "SU" Exchanger, a Manufacturer's Data report for Unfired Pressure Vessels, Form No. U-1 as required by the A.S.M.E. Code rules, is furnished. This form is signed by a qualified inspector, holding a National Board Commission, certifying that construction conforms to the latest A.S.M.E Code for unfired pressure vessels. The A.S.M.E. "U" symbol is stamped on each exchanger.

For complete information send for "SU" Catalogs No. SC-159 and SI-159.



Mr. George Stewart, mechanical contractor for
Jane Addams Elementary School, Melrose Park, Illinois, says:

"Honeywell stayed on to Jane Addams job to our

Mr. George Stewart, in the equipment room at Jane Addams Elementary School. The Honeywell panel behind him enables the building engineer to check the entire pneumatic control system.

check out the complete satisfaction"

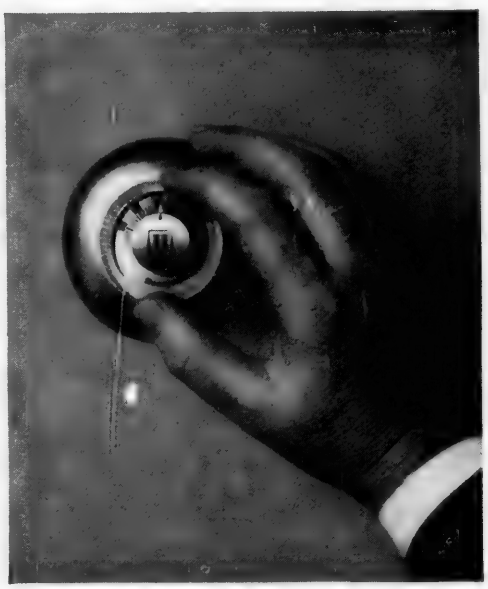
JANE ADDAMS ELEMENTARY SCHOOL
Architect-Engineer: Kefer & Cronin, Chicago
Mechanical Engineer: Albert W. Marshall, Chicago
General Contractor: Louis Macro Co., Melrose Park, Illinois
Mechanical Contractor: Tropf Heating Co., Broadview, Illinois

At Jane Addams Elementary School, Honeywell servicemen stayed on the job long after the building was completed to make sure the temperature control installation operated perfectly

"Honeywell really came through for us on the Jane Addams job," says Mr. Stewart. "They saw that the temperature control equipment was delivered on time and installed on time. They turned in clear shop drawings of the temperature control system. They gave us good supervision during installation, then stayed on to thoroughly check out the system to make sure it worked well under actual school conditions."

At Jane Addams Elementary School, Honeywell installed Pneumatic Round thermostats on the wall of every classroom. On the wall, they feel temperature in the classrooms the way students do. And they are also more convenient to read and adjust to offset varying effects of weather, occupancy and student activities.

You can depend on Honeywell to help you do a quality job. Fine controls, accurate specifications, prompt delivery and supervised installations are assured with Honeywell on your team. And only Honeywell gives you a choice of all three types of control systems—pneumatic, electric and electronic. For further information, call your nearby Honeywell office. Or write Honeywell, Dept. HV-1-32, Minneapolis 8, Minnesota. *Sales and Service offices in all principal cities of the world.*



This is the Honeywell Round, the world's most popular thermostat. It enables teachers to adjust temperatures to fit specific learning activities.

Honeywell

First in Control

SINCE 1885

CLOGGING by high wet-strength paper products is IMPOSSIBLE!

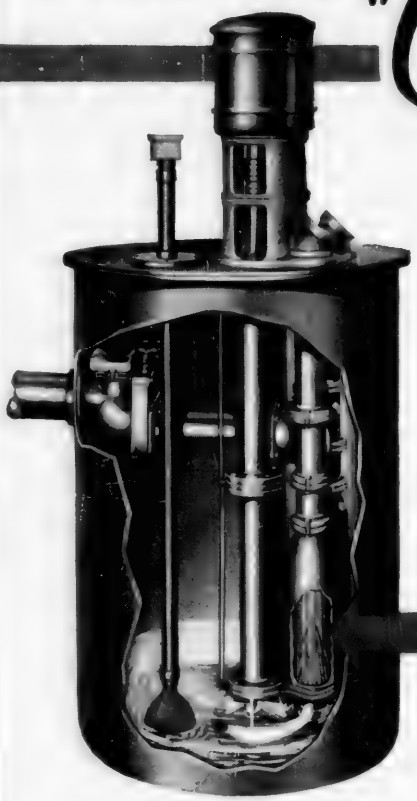
with the new FLUSH KLEEN® system from "Chicago"

This clogging cannot happen with the FLUSH KLEEN System

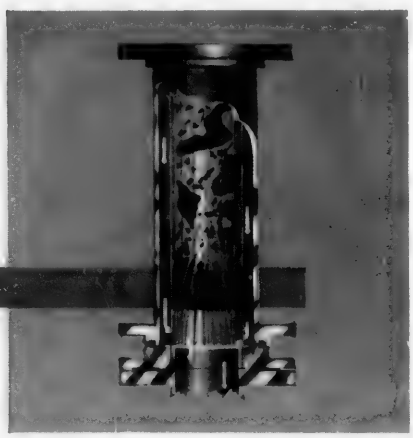
CLOGGED— Paper toweling piled up at eye of 2½" sphere design impeller.

CLOGGED— Complete clogging of 2½" sphere design impeller.

CLOGGED— Complete clogging of 3" sphere non-clog impeller.



THE FLO-THRU STRAINER, heart of the Flush Kleen system continuously permits only clear liquid to flow through the strainer into the pump at highest solids loadings.



SOLIDS NEVER REACH THE IMPELLER

Impeller handles only clear liquid. Shaft, bearings and motor are never subjected to severe strain and wear due to partially or completely clogged impellers. The life of a Flush Kleen system is therefore much longer than that of so-called non-clog type pumps. "Down time" due to clogging is eliminated and a quiet, smooth operating unit is assured.

For further information see your local Chicago Pump distributor or write Chicago Pump for Bulletin 122-D.

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Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
HYDRODYNAMICS DIVISION

CHICAGO PUMP

622J DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

Easily-installed PPG Neoprene-coated Duct Liner now meets fire requirements, provides extra margin of safety on ductwork installations.

NOW—PPG Fiber Glass Duct Liner Carries the UL Label

PPG Neoprene-Coated Superfine Duct Liner Meets All Requirements of NBFU Bulletins No. 90-A and 90-B for Ducts

YOUR ASSURANCE OF SAFETY

PPG is proud to announce that its Neoprene-coated Superfine Fiber Glass Duct Liner has been thoroughly tested according to the condition determined by National Board of Fire Underwriters, and has met the Board's rigid safety requirements in compliance with Bulletins No. 90-A and 90-B for ducts. It now bears the label of the Underwriter's Laboratories, Inc.

For you, this means that PPG Neoprene-coated Fiber Glass Duct Liner meets fire requirements and provides that extra margin of safety on any ductwork installation.

PLUS ALL THOSE EXTRA PPG ADVANTAGES...

. . . such as lightweight, easy handling, easy cutting and piecing, low wastage, fast installation, fine acoustical qualities, good thermal barrier characteristics, low resistance to air flow, no air erosion; and lifetime service, because it won't rot or decay, is not affected by humidity or dryness.

Give PPG Fiber Glass Duct Liner a try. It offers you a combination of top-flight insulation and economy. For full information, call your nearest PPG Fiber Glass Sales Office, or write *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pennsylvania.*

Sales Offices: Atlanta, Attleboro, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Fort Wayne, Houston, Kansas City, Louisville, Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis and Washington.

FIBER PPG GLASS PITTSBURGH PLATE GLASS COMPANY

Now—17 Trane Torrivent large area heating-

Two-fan unit. Vertical floor-mounted or wall-hung unit with de luxe discharge plenum and intake box.

New Auditorium Torrivent (*horizontal*). Used in factories, auditoriums, convention halls, gyms, etc. Extremely quiet, economical to operate.

Expanded size range lets you choose a unit that fits your job exactly

Now from the TRANE Torrivent line you can select the capacity you need to meet the requirements of any large interior space. Thorough testing and rating of the Torrivent as a unit assures accurate capacity ratings.

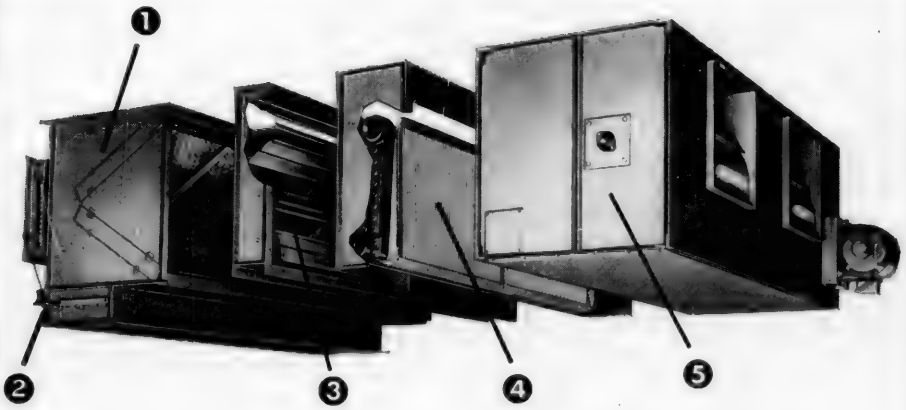
Versatile line. Seventeen Torrivent sizes give you a selection of heating capacities that range from 20,000 to 3,800,000 Btu. Choice of six models—vertical floor; horizontal ceiling; inverted ceiling; horizontal floor; vertical wall; inverted wall—with one to three fan units delivering from 600 to 54,000 cfm.

Sectionalized construction. You get the benefit of sectionalized construction that permits flexible use of any of the matched components and accessories. This is why Torrivent is a highly flexible line—adaptable for more applications.

Exclusive coil design. New TRANE NS Steam Distributing Coil with exclusive Kinetic Orifices and 1″ OD tubes assures even temperature distribution across entire coil face.

Find out more. Ask your nearby TRANE sales office for complete facts on the Torrivent line. Or write TRANE, La Crosse, Wisconsin.

sizes to solve more ventilating problems!



1 Combination filter-mixing box. Mixing box damper blades set to direct two streams of entering air on a merging course—reduces stratification. All air is thoroughly filtered.

2 Ball-joint damper linkage. Nonbinding, prelubricated ball-joint damper linkage is used on all face-and-bypass and mixing box sections. Absorbs minor misalignment and stress. Requires little maintenance.

3 Face-and-bypass dampers. Internal face-and-bypass section uses opposed blade dampers for accurate temperature control. Blades are locked securely and permanently positioned on splined rods which rotate on rustproof, permanently-lubricated nylon bushings. Moving from fully closed to fully open, relative position of blades will not vary.

4 Heating coil. New TRANE Sigma-Flo Coil assures greater effectiveness in heat transfer. Turbulent action on fin surface prevents buildup of any insulating film of air. Steam distributing coil design with 1" OD tubes virtually eliminates condensate bridging—protects against freeze-up. One row of tubes meets most capacity requirements.

5 Fan section. Fans have low outlet velocities for smooth operation. Every fan section balanced electronically after complete assembly—assures efficient, quiet operation.

Torrivent design assures lower operation and maintenance costs

Low operating cost. Torrivent fans, manufactured by TRANE, have an advanced design that assures peak operating efficiency. Fan horsepower requirements are kept low for economical operation. TRANE also offers a wide selection of sizes and unit combinations —so you don't pay for operating unneeded capacity.

Low maintenance cost. All coils are removable and accessible. Coils are pitched in every unit to give complete drainage.

Ball bearings are lubricated for life. Reduces maintenance—eliminates danger of improper lubrication. Bearings selected for a service factor of 3.

Rugged construction. Casing and accessories are uniframe construction, with heavy gauge phosphatized steel. Coils have heavy semi-steel cast headers with tubes rolled and bushed for longer life.

See the TRANE Torrivent at the ASHRAE Show Chicago, February 13-16

BOOTH 3 and 7

For <u>any</u> air condition, turn to

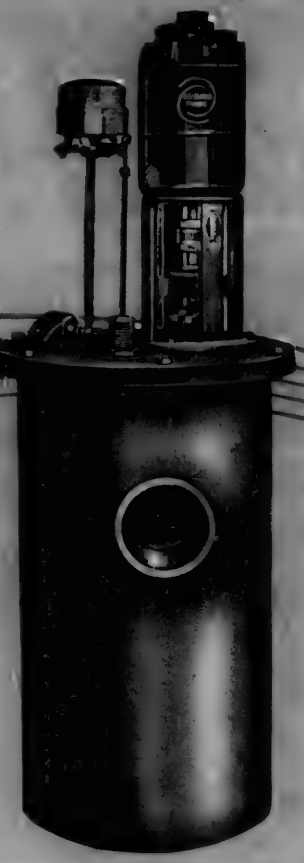
TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO

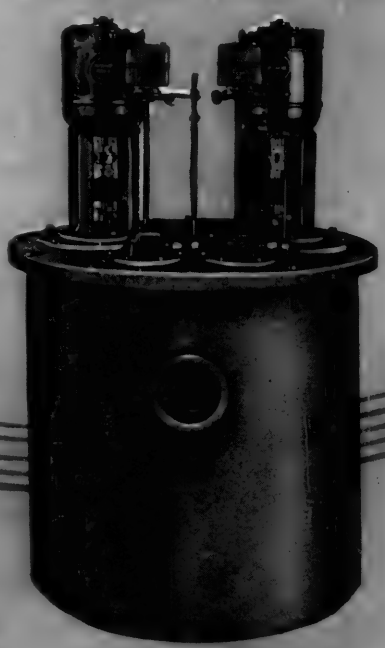
100 U. S. AND 19 CANADIAN OFFICES

SKIDMORE



SKIDMORE SINGLE UNIT UV PUMP

SKIDMORE DUPLEX UNIT UV PUMP



Type UV condensate pump is ideal for return of condensate to the boiler or other points. Built in both single and duplex units . . . type UV pump can be installed with cover plate flush with floor . . . motor and float switches are easily accessible above flood level and out of danger.

Send for New

UV PUMP

Bulletin

No. 19-B

Specify Skidmore on your next job . . . the new wide range of pump types, sizes, capacities and pressures are described in new bulletin. Skidmore builds a pump to meet your particular requirements . . . write for complete engineering data on all Skidmore Pumps or contact the Skidmore representative in your locality.

Skidmore Pumps have set a standard of performance and dependability since 1921.

SKIDMORE PUMPS

SKIDMORE CORPORATION ST. JOSEPH MICHIGAN

the skating is fine in Atlantic City

. . . on rinks built with steel pipe

"Ice skating on our private rink" is a sign now frequently seen next to "Tourist Accommodations" in Atlantic City, N. J. The four establishments shown here have found this added attraction a great help in extending the tourist season throughout all twelve months of the year.

Attractive, too, to the builder and contractor alike, is the promise of long rink life given to each of these rinks by Bethlehem steel pipe. And the low cost of steel pipe is another big feature—it's considerably less expensive than any other ferrous piping material. What's more, steel pipe is available in double-random lengths—and can be fabricated *cold!*

Practical advantages like these make steel pipe the first choice for ice rink installations. Your pipe distributor will be glad to talk it over with you. Or call the nearest Bethlehem sales office.

Steel

for Strength . . . Economy . . . Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Colony Motel

Ice rink: 35 x 70 ft
Architects: A. L. & Stanford G. Brooks
Engineer: Jack P. Hartmann
Contractors: Benjamin E. Labov & Sons
Pipe Jobber: Seashore Supply Co.

Empress Motel

Ice rink: 40 x 100 ft
Architect: Rodney C. Williams
Engineers: S. B. & B. H. Strouse
Contractors: Benjamin E. Labov & Sons
Pipe Jobber: Seashore Supply Co.

Chelsea Hotel

Ice rink: 35 x 70 ft
Piping Engineers and Contractors: Benjamin E. Labov & Sons
Pipe Jobber: Seashore Supply Co.

President Hotel and Motel

Ice rink: 45 x 90 ft
Architect: Rodney C. Williams
Engineers: S. B. & B. H. Strouse
Contractor: Wm. J. Crane Company
Pipe Jobber: Seashore Supply Co.

It's the Industry's Target
and should be yours, too

to SEE, LEARN, COMPARE
WHAT'S NEW in
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AIR CONDITIONING • VENTILATION

SEE on display the newest in product developments that the industry has to offer for indoor climate control, covering domestic, commercial and industrial applications.

LEARN from the top executives, engineers and salesmen, how their products can best be applied to meet your specific requirements.

COMPARE what you see and learn from the more than 500 manufacturers participating in the exhibition—what better way to find the product or system that best suits your company's needs?

There is no other way in which so much useful information on new developments can be obtained—in such a limited period of time—than through a visit to the more than 500 fact-filled displays covering all phases of heating, refrigeration, air-conditioning and ventilation.

15th INTERNATIONAL HEATING &
AIR-CONDITIONING EXPOSITION

AUSPICES ASHRAE

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Management: International Exposition Company

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FEB. 13-16, 1961

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Air-Conditioning units and systems, Boilers, Burners, Fans, Blowers, Bearings, Condensers, Compressors, Controls, Coolers, Fittings, Filters, Exhausters, Heat Exchangers, Dehumidifiers, Pipe Tools, Pumps, Preheaters, Motors, Meters, Piping, Valves, Hose, Heaters—Coal, Electric, Gas, and Oil, Furnaces, Grilles, Hangers, Gages, Ventilators, Water-Treatment, Tubing, Traps, Cooling Zoners, Thermostats, Thermometers, Switches, Separators, Regulators, Refrigerants, etc.

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ASHRAE Members attending meeting are admitted on their Society badges. Exposition registration not necessary.

15TH INTERNATIONAL HEATING & AIR-CONDITIONING EXPOSITION

480 Lexington Avenue, New York 17, N. Y.

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Company_____

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City_____ Zone_____ State_____

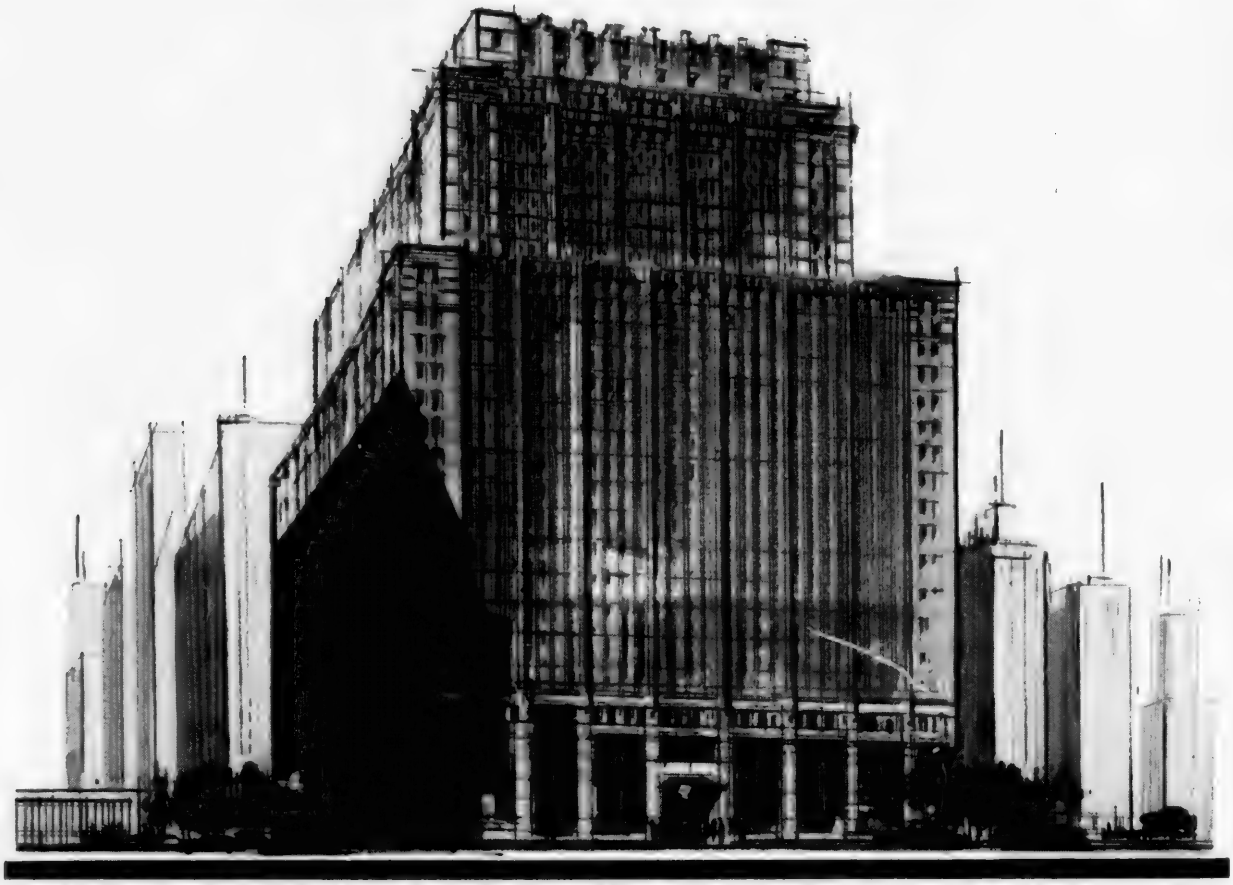
Products or Industry_____

Type of Business_____

☐ Check here if application form for hotel reservation is required.

AHV

Climate by Chrysler



2 Park Avenue, New York City. Consulting Engineers: Sears and Kopf; Mechanical Contractor: Kennedy-Scheidel-Young, Inc.; Electrical Contractor: Theodore Kaish, Inc.

Chrysler Air Conditioning tailored to tenant needs installed a floor at a time in 27-story building

During the past five years, scores of Chrysler air conditioners have been installed at 2 Park Avenue, New York City. What has been one of the longest air conditioning jobs in history has also been one of the most successful.

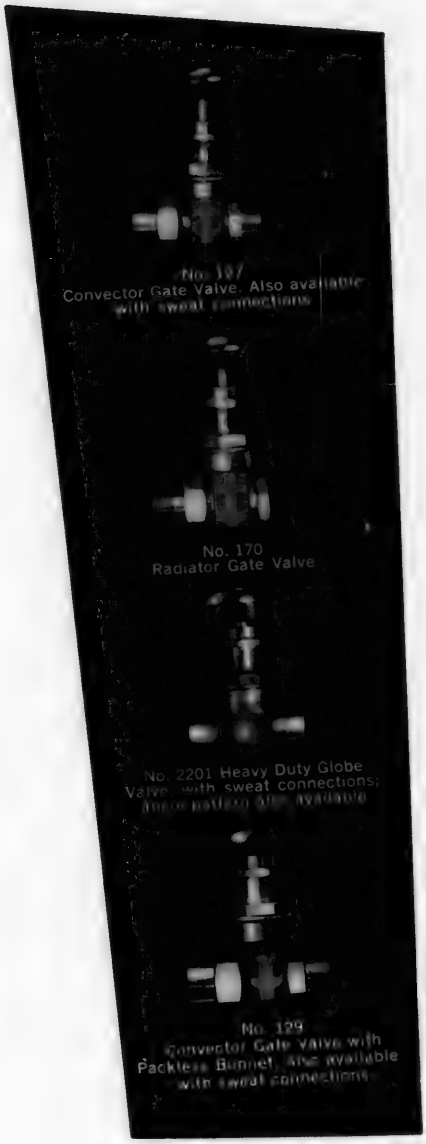
By handling this 27-story building zone by zone and floor by floor, about 1400 tons of Chrysler equipment have been installed . . . with an absolute minimum of inconvenience to tenants. As tenants move in or renew leases, they are consulted as to exact air conditioning requirements. Each then gets the system best suited to his needs.

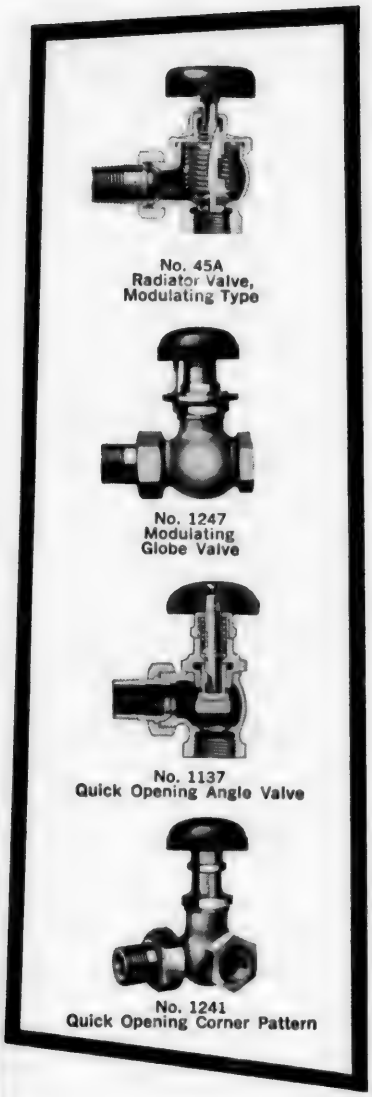
This unusual method is flexible—Chrysler can supply packaged units, chillers or room units as needs demand. And it is economical—all air conditioning equipment taps into central electrical, water and air connections which serve the entire building.

Chrysler engineers worked closely with the consulting engineer and contractor during the advance planning of this complex air conditioning problem. They will be as happy to cooperate with you. For information on their services and Chrysler Air Conditioning equipment, write today.

CHRYSLER AIRTEMP

Airtemp Division, Chrysler Corporation, Dept. D-11, Dayton 1, Ohio
In Canada: Therm-O-Rite Products, Ltd., Toronto, Ontario


No. 107
Convector Gate Valve. Also available with sweat connections
No. 170
Radiator Gate Valve
No. 2201 Heavy Duty Globe Valve, with sweat connections; flange pattern also available
No. 129
Convector Gate Valve with Packless Bonnet, also available with sweat connections



FOR STEAM HEATING • RADIANT HEATING • HOT WATER HEATING • AIR CONDITIONING

SARCO RADIATOR VALVES

You can meet your most exacting needs in radiator valves with Sarco. For steam: Bellows-Packless, Spring-Packless, and Gland-Packed. For hot water: Spring-Packless and Gland-Packed. Made in globe and gate types, angle and corner patterns, modulating and quick opening. Sizes from ⅜" to 2", pressures up to 200 psi.

WRITE FOR YOUR FREE COPY

of the new Bulletin No. 225, covering radiator valves, balancing fittings, and access boxes, with sizes, capacities, and roughing-in dimensions.

SARCO

SARCO COMPANY, INC.
AN AFFILIATE OF SARCOTHERM CONTROLS, INC.
635 MADISON AVENUE, NEW YORK 22, N.Y.
PLANT: BETHLEHEM, PA.

For trouble-free underground hot pipe insulation specify GILSULATE® with Engineer-Supervised Installation

Every engineer charged with the responsibility of designing a central heating system to heat all buildings of a college, institution or industrial plant knows the money-saving advantages of such a system if properly planned. But he is aware that planning the underground piping can involve many problems, for the system must provide proper insulation and also protect pipes against corrosion, chemical and electrical attack.

The easy, one-step solution to many of the problems of underground hot pipe insulation is to call the GILSULATE distributor in your area: first, for the superior quality of the insulation material he sells and, secondly, for the excellent service he has to offer.

GILSULATE is a naturally-occurring mineral which, because of its unique chemical and physical properties, is chemically neutral in all soils, dielectric, impervious to mold, rodents and plant growth, and is water-resistant. Its thermal efficiency, low installation cost and long service life are supported by extensive laboratory and field research, and also by years of successful use in thousands of installations throughout the world.

Service that saves time and trouble—It is as important to our reputation that GILSULATE be used properly as it is for the engineer to assure his customer of an efficient, economical installation. Our distributors' experienced mechanical engineers will work with you in preparing underground piping plans, checking soil conditions and arranging for supervision of the installation work. And, without any cost to you, plans and specifications will be checked by American Gilsonite's Engineering Department.

Full-time engineer supervision of installations—Every GILSULATE installation of 30 tons or more is supervised by an American Gilsonite Company field service representative who stays on the job until it is completed. Smaller jobs are inspected by the distributor's engineer. This is a guarantee to everyone concerned...owner, architect, engineer, mechanical contractor and materials supplier...that every step of the job will be exactly to specifications.

Without obligation, we will be pleased to send you technical information on GILSULATE insulation so you can evaluate the merits of this low-cost, poured-in-place material. We will also put your name on the mailing list to receive free copies of PIPE INSULATION NEWS.

Once you have learned the merits of GILSULATE, we feel certain you will want to write your "specs" to assure the use of GILSULATE...*with engineer-supervised installation.*

FACTS ABOUT GILSULATE

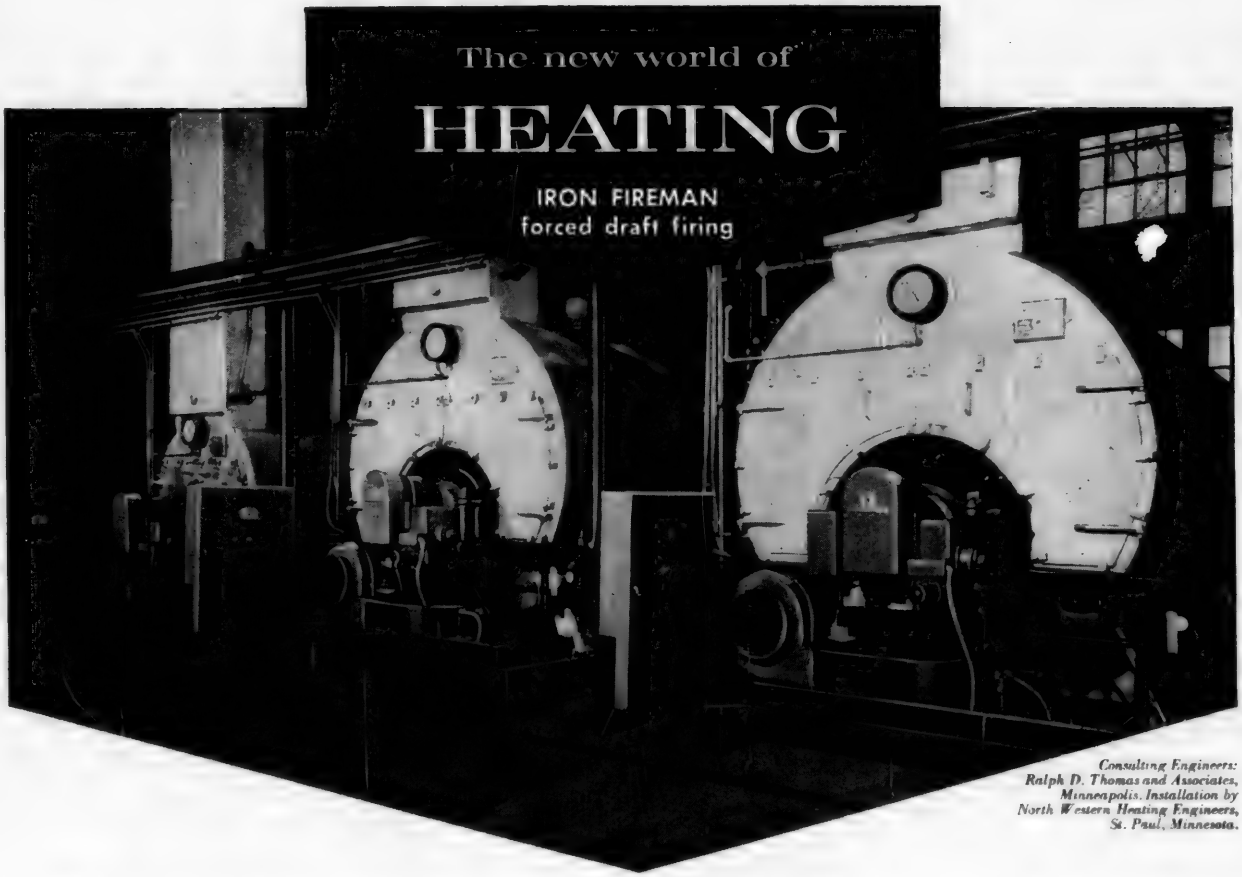
1. **Easy-to-use**—just pour, shovelpoint and tamp...pipe heat does the rest.
2. **Forms protection against heat loss** and all hazards commonly encountered by buried hot pipes.
3. **Needs no housing or mechanical sheaths:** no mixing, special handling or equipment.
4. **Only needs normal pipe spacing:** for multiple pipe or cramped conditions.
5. **Four types available:**
   Type A for 220-300° F. temp. range
   Type B for 300-365° F. temp. range
   Type Special B for 365-420° F. temp. range
   Type C for 420-520° F. temp. range

THE INSULATION FOR LIFETIME PROTECTION OF UNDERGROUND HOT PIPES

GILSULATE®

AMERICAN GILSONITE COMPANY

Municipal Airport P. O. Box 15, Salt Lake City, Utah
Affiliate of Barber Oil Corp. & Standard Oil Co. of California
Distributors in Principal Countries of the World



Consulting Engineers: Ralph D. Thomas and Associates, Minneapolis. Installation by North Western Heating Engineers, St. Paul, Minnesota.

This new heating plant increased boiler capacity 70%, yet will return the investment in 7 years

The Minnesota Masonic Home in Minneapolis faced a problem that is familiar to many owners of old heating plants—should the old plant be modernized or replaced?

After a thorough study of several alternatives, the engineering firm of Ralph D. Thomas and Associates recommended a complete replacement. The three Iron Fireman-Kewanee boiler-burner units shown above provide extra capacity for future needs, while cutting steam costs so sharply that engineers estimated they will pay for themselves in seven years.

COMPLETE, PACKAGED FIRING SYSTEM

The first big saving was in installation—the three units were moved in intact. No boiler settings, no brickwork, no special wiring required. The factory assembled units included boilers, burners, forced draft air supply, wired and tested control panels and fuel systems, all mounted on a permanent base. Low operating costs were the result of high combustion efficiencies (reduced fuel bills) and low maintenance. With packaged installation, factory responsibility covers practically the entire job.

FOR OIL, GAS OR DUAL-FUEL FIRING

Oil models fire any grade of oil from No. 2 to No. 6. Gas models take any type of high or low pressure gas. With dual-fuel models, fuels can be switched at a moment's notice with either manual or automatic controls.

Mail coupon for full information.

IRON FIREMAN

HEATING AND AIR CONDITIONING
AIRCRAFT COMPONENTS AND EQUIPMENT
MISSILE AND AIRCRAFT GYROSCOPES
ELECTRONIC EQUIPMENT
CONTROL INSTRUMENTS

Iron Fireman Mfg. Co., 3102 W. 106th St., Cleveland 11, Ohio
(In Canada, 80 Ward St., Toronto)

Please send complete technical description and specifications on Iron Fireman forced draft firing.

Name_____

Firm_____

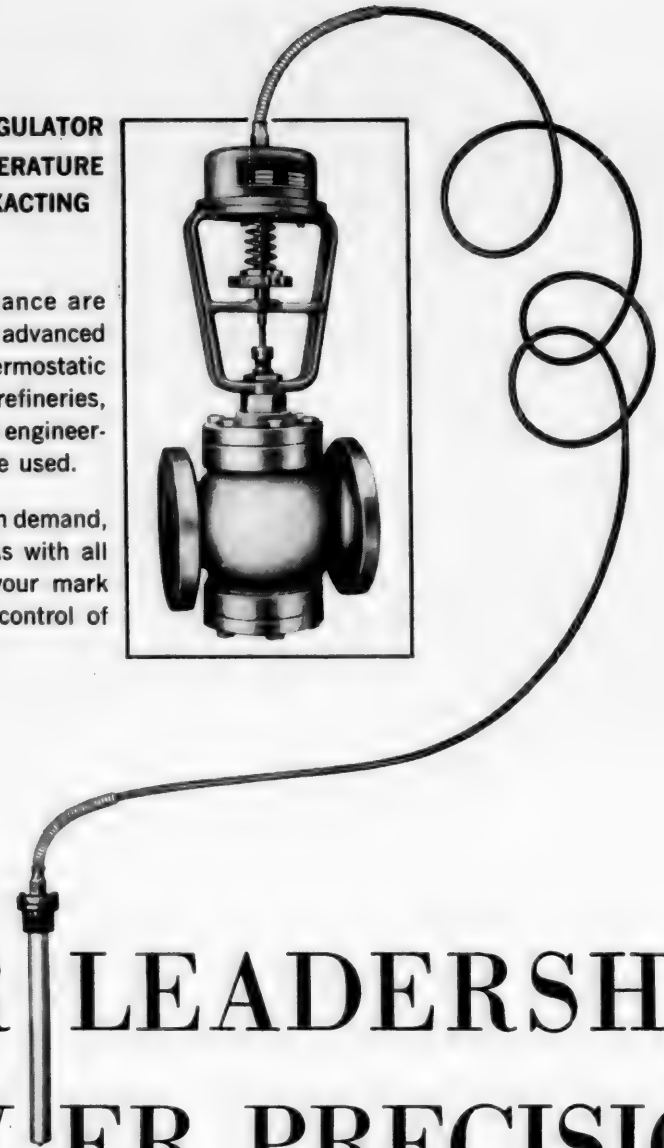
Address_____

City_____ State or Prov._____

LAWLER TYPE "S" TEMPERATURE REGULATOR ... UNEQUALLED ACCURACY IN TEMPERATURE CONTROL FOR INDUSTRY'S MOST EXACTING REQUIREMENTS.

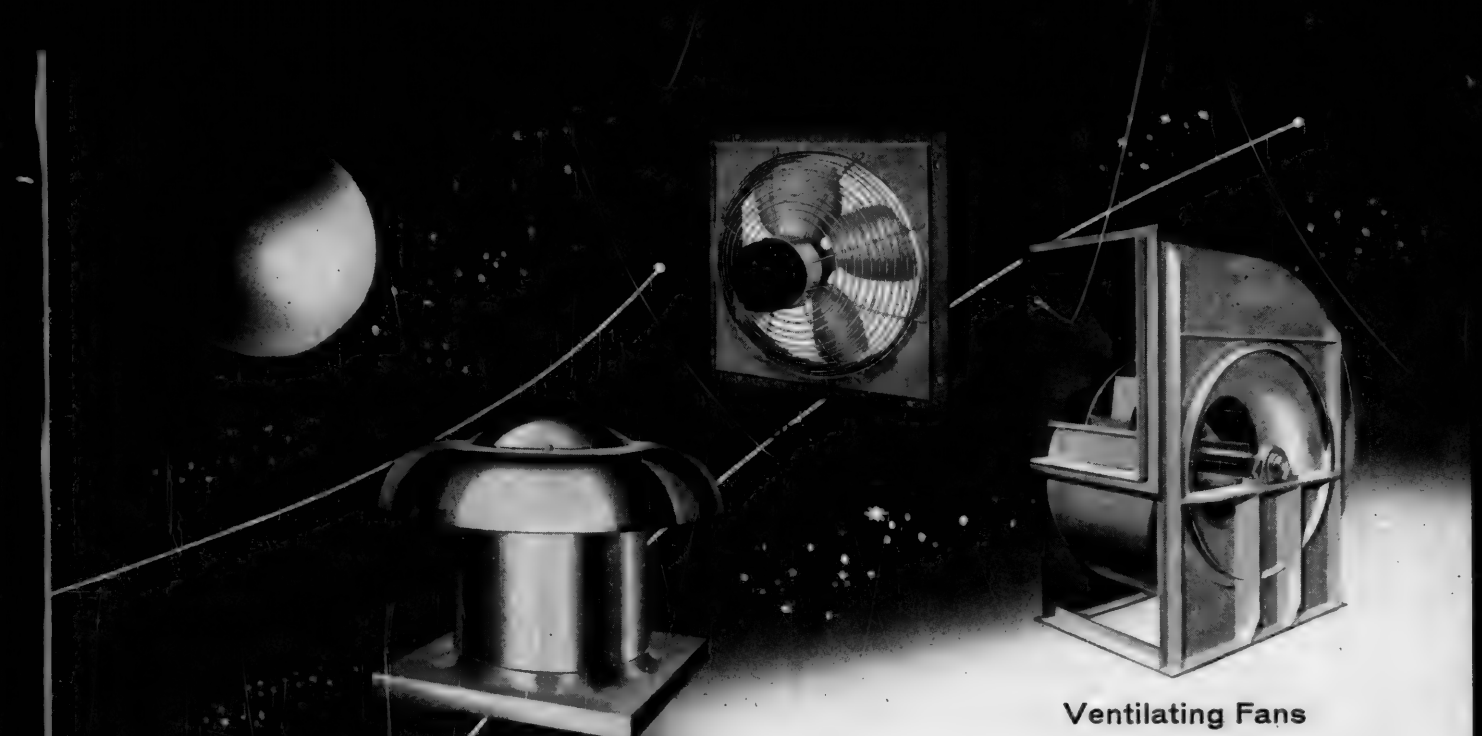
High sensitivity . . . rugged performance are combined in the Type "S" by Lawler's advanced engineering design to meet modern thermostatic control needs in processing, dairies, refineries, chemical plants, maritime services, diesel engineering, wherever steam, gases or fluids are used.

The Type "S" goes into action instantly on demand, maintaining the desired temperature. As with all Lawler Line valves, the Type "S" is your mark of performance quality . . . precision control of temperatures.



LAWLER LEADERSHIP WHEREVER PRECISION CONTROL OF TEMPERATURES COUNTS!··· LOOK TO LAWLER····· FIRST!

LAWLER AUTOMATIC CONTROLS, INC. MT. VERNON, NEW YORK



Ventilating Fans

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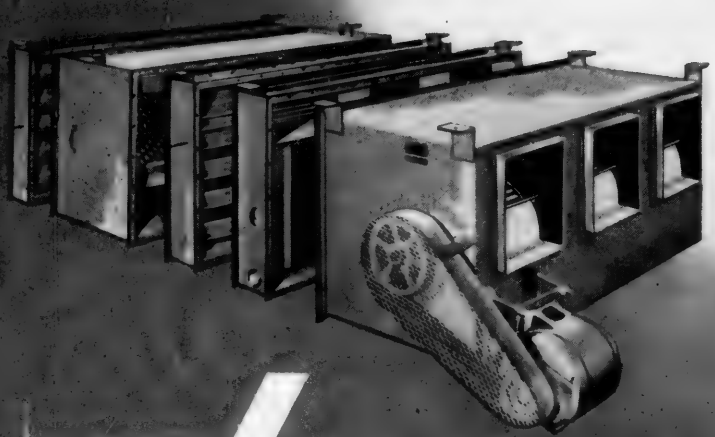
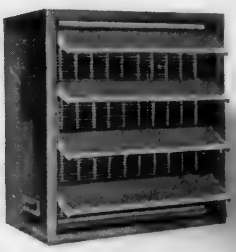
...a galaxy of products to solve your air handling problems...

Industrial Fans



Centrifugal Unit Heaters



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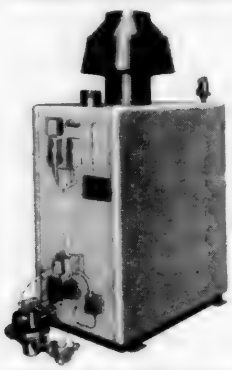

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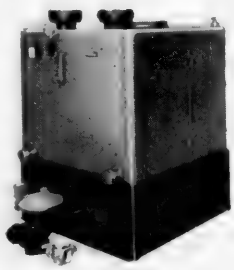

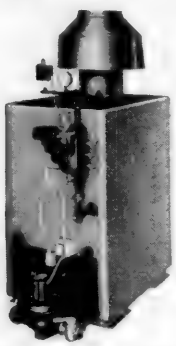

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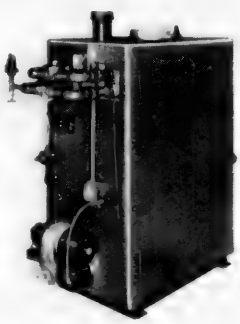

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How Travelers air conditioned without stealing office space

A tremendous air conditioning modernization* is now in progress at the home offices of The Travelers Insurance Companies at Hartford. To save critical space and to insure quiet operation, they selected 49 centrifugal fans of a totally new type: in-line, Airfoil, centrifugal fans from Westinghouse. These new Centriline® fans take up less than half the installed space of conventional centrifugal fans.

If this new type of fan didn't exist, Travelers would not have been able to install the necessary air handling equipment in their existing equipment rooms. Valuable office space would have had to be "stolen" to accommodate the larger conventional fans.

The new Centriline fans also insure quiet operation. The secret is a Westinghouse exclusive: the Airfoil-bladed centrifugal wheel. For both commercial and industrial installations, you can save space, cut installation costs and reduce noise with Centriline fans. Check your architect or consulting engineer. Mail coupon for detailed catalog. J-80721

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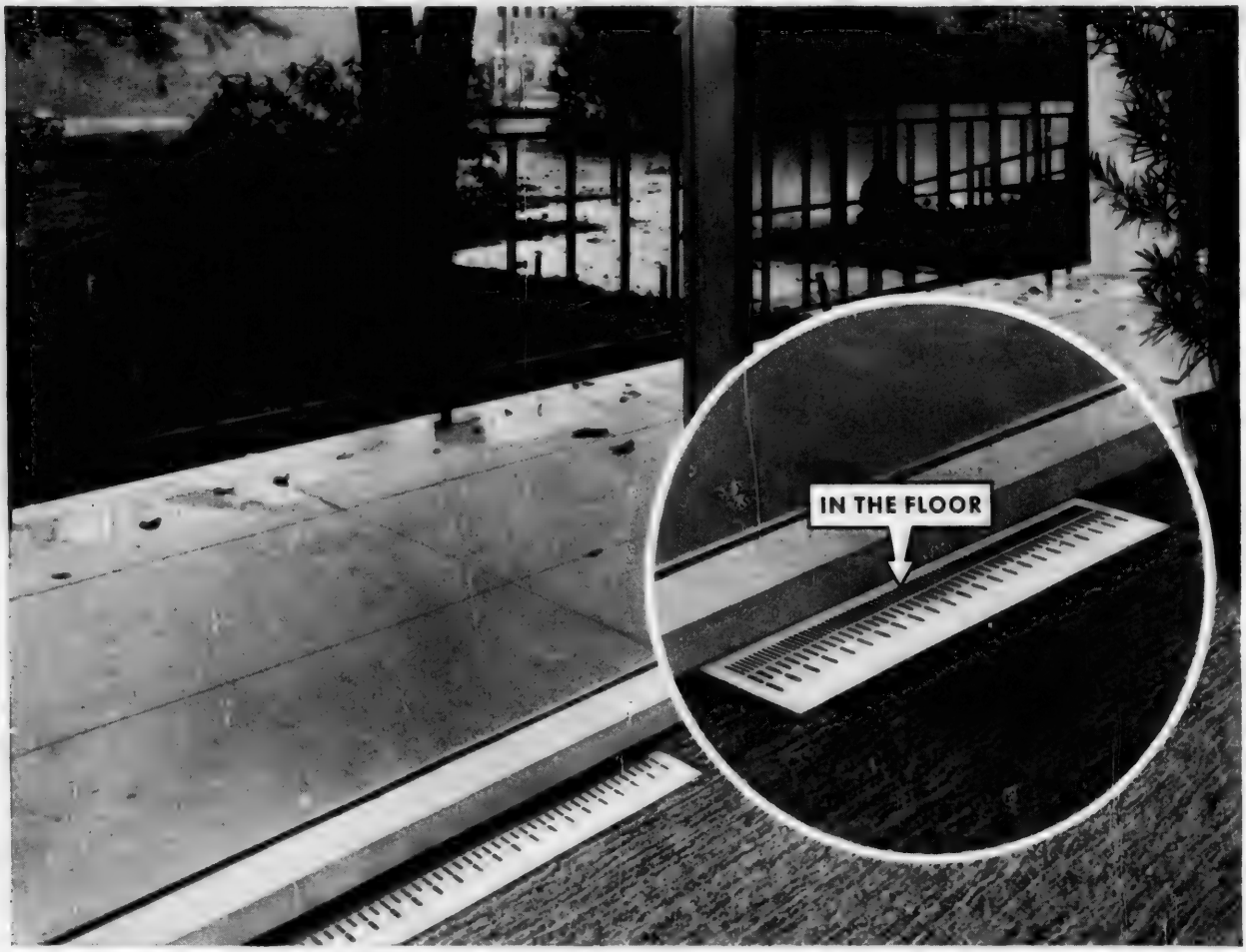
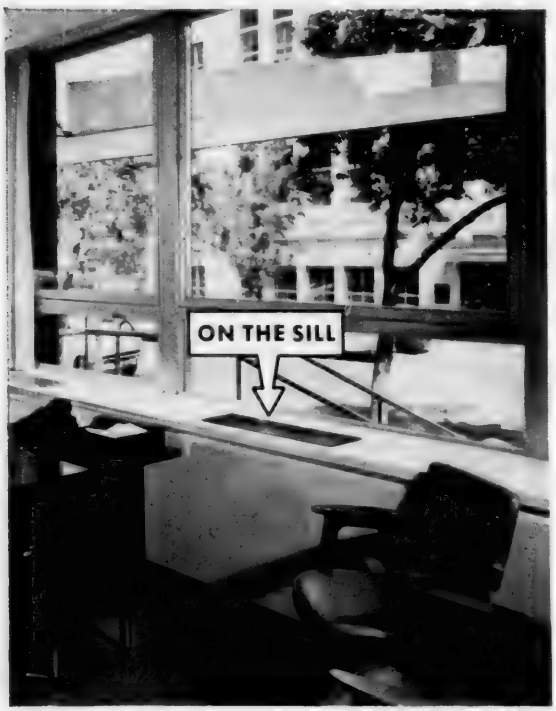


New Anemostat Stainless Steel Diffus-A-Plate



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Anemostat Diffus-A-Plates for floor or sill application diffuse a pattern of conditioned air up the exterior wall and across the ceiling, insuring draftless comfort in the occupied zone.

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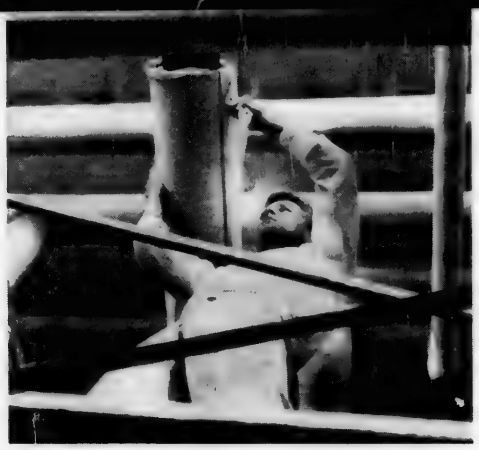
No. 1* in a series for your G-B SPEC. FILE

Suggested specifications for insulating INDOOR HEATED PIPING with G-B SNAP*ON Glass Fiber PIPE INSULATION



DESCRIPTION

G-B Snap*On is the original one-piece, hinged pipe insulation molded entirely of fine glass fibers. It is manufactured in thicknesses from ½" to 3", in 3-ft. and 6-ft. lengths, for cold and heated piping from sub-zero to 350°F. temperatures. "K" factor of G-B Snap*On is second to none among all general purpose pipe insulations. Because it is made entirely of glass fibers, G-B Snap*On pipe insulation offers all the advantages of glass itself. It will not burn, is not affected by moisture, will not corrode metal, is lightweight and easy to handle and apply, is highly immune to damage, and is so permanent it will last indefinitely!

SAMPLE MATERIAL SPECIFICATION

HOT WATER PIPING—Insulating Material

All hot water service supply piping shall be insulated with Gustin-Bacon Snap*On glass fiber pipe insulation in one piece molded sections ...." thick. Piping shall be clean and dry and shall be tested before insulation is applied.

LOW PRESSURE STEAM OR HOT WATER SUPPLY AND RETURN PIPING—TO 350° F.—Insulating Material

All low pressure steam or hot water supply and return piping used for heating, located indoors in unconditioned areas or where touch temperature insulation is required, shall be insulated with Gustin-Bacon Snap*On glass fiber pipe insulation in one piece molded sections ...." thick. Piping shall be clean and dry and shall be tested before insulation is applied.

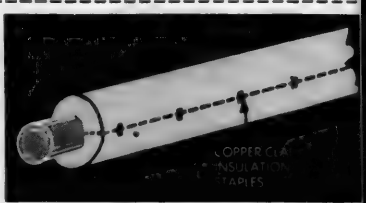
NOTE: Use facing table below to specify appropriate jacket with above specifications.

APPLICATION SPECIFICATION

INSULATION OF CONCEALED PLUMBING AND HEATED PIPING

Insulation for concealed piping shall be applied to the pipe without jackets. The end joints shall be tightly butted and the single longitudinal seam held together with copper-clad insulation staples, 4 staples per 3' section.

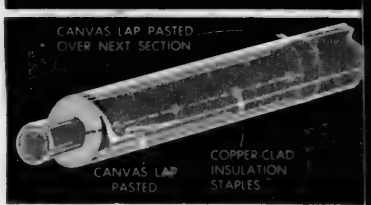
CONCEALED PIPING



INSULATION OF EXPOSED PLUMBING AND HEATED PIPING

Insulation for exposed piping shall be applied to the pipe with factory applied canvas jackets. The end joints shall be tightly butted and the single longitudinal seam held together with copper-clad insulation staples, 4 staples per 3' section. The factory applied canvas jacket laps shall be neatly pasted in place. *(Note: The insulation may be finished off by applying metal bands, 2 per section. One band shall be placed at the mid-point of the covering and one centered over the joint between sections.)*

EXPOSED PIPING



RECOMMENDED JACKETS FOR G-B SNAP*ON PIPE INSULATION FOR HEATED PIPING

ORDERING NAME	DESCRIPTION	SEC. LENGTH	VAPOR BARRIER	WHERE TO USE
CANVAS	Standard weight or 4, 6, and 8 ounce jackets, factory applied, with end and side joint overlaps. Surface suitable for sizing and painting.	3'	No	On interior hot piping to 350° requiring no vapor barrier and where finished appearance is an important consideration.
LIGHT DUTY JACKET (Available on ½" and ¾" wall thickness only)	A two layer laminate of .00035" aluminum foil adhered to a 60-lb. white crepe Kraft paper. Presents a neat finished appearance. Moisture vapor transmission rate of less than .03 perms, factory applied with a 2" longitudinal overlap. Joints are sealed with factory furnished 4" wide tapes.	3'	Yes	On interior hot or cold piping operating at temperatures from 350° F. to 50° F. where a finished appearance is required. For temperatures below 50° F. dual temperature jacket should be used.
PLAIN	No jacket. Smooth glass fiber surface.	2' and 6' Depending on Size	No	On interior concealed hot piping. Excellent for industrial applications where no vapor barrier is required. Perfect when paint or plastic finishes are to be applied in the field, also recommended where weatherproofing jackets, aluminum, or sheet metal coverings are to be field applied.

*Complete series of G-B Snap*On specifications will appear in this publication in the coming months. Each will be designed to be clipped from the publication and placed in your spec file. However, if you would like to have all G-B Snap*On specifications at this time, simply write:

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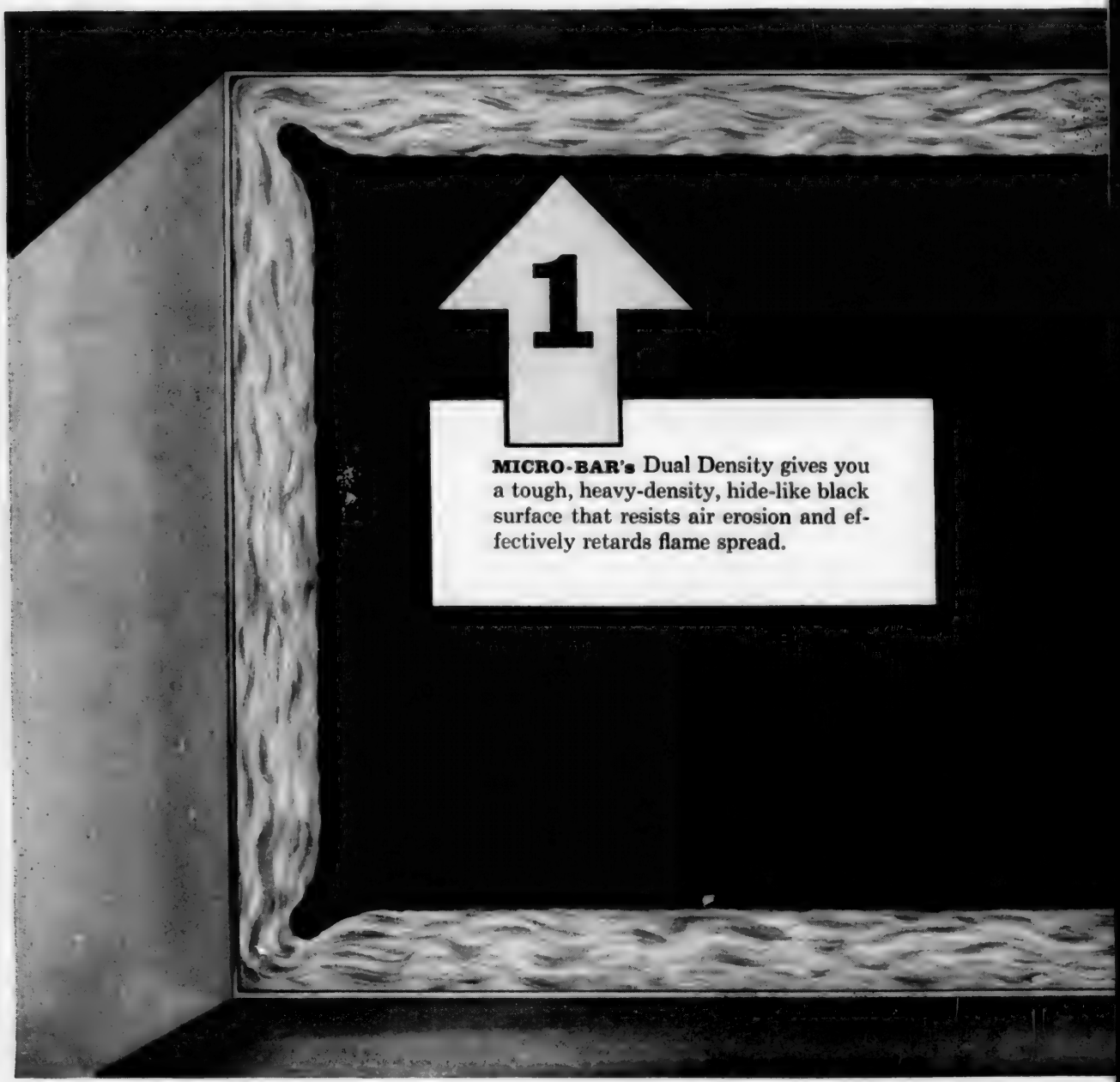
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MICRO-BAR's Dual Density gives you a tough, heavy-density, hide-like black surface that resists air erosion and effectively retards flame spread.

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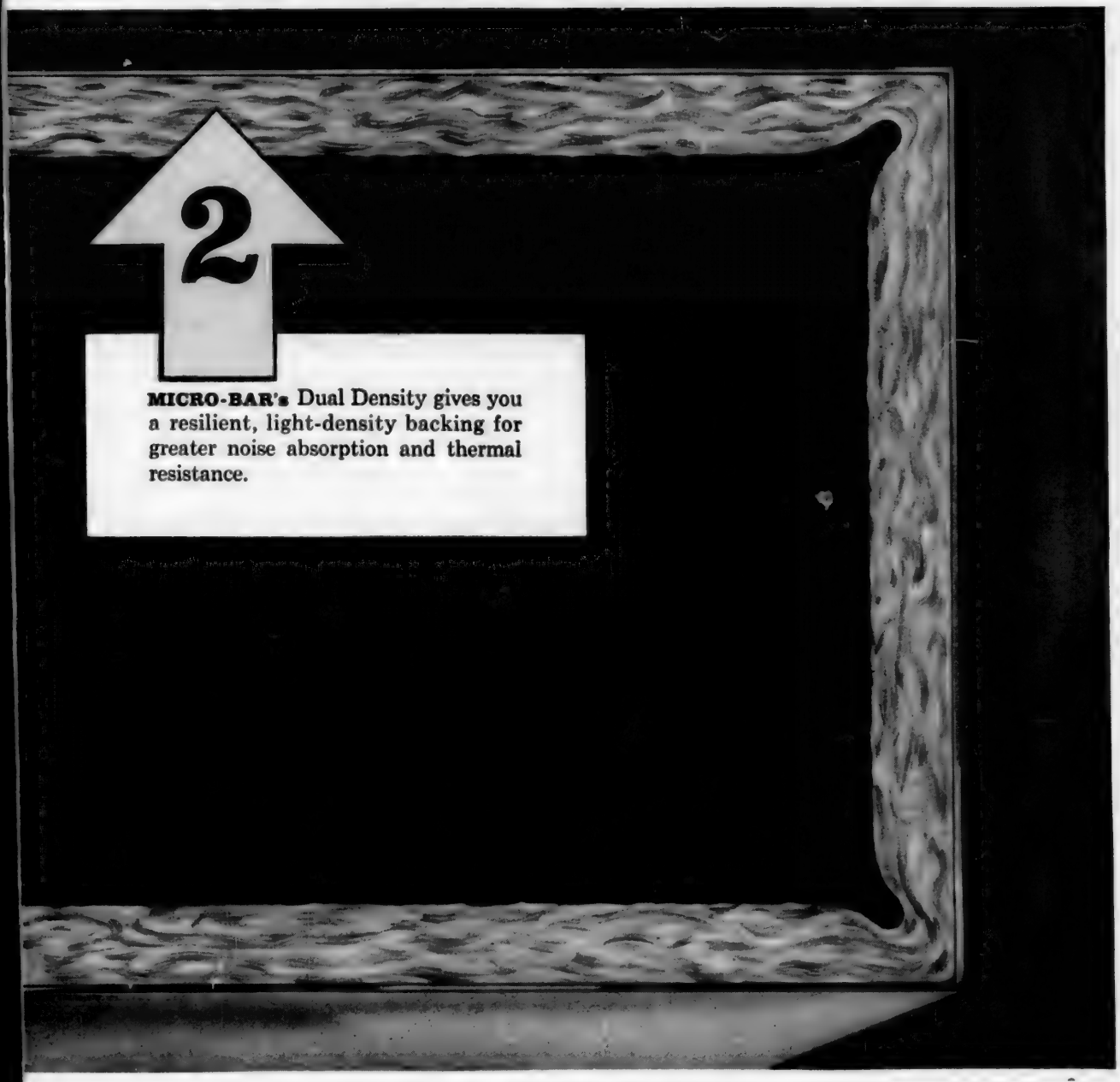
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THIS NEW VACUUM HEATING PUMP

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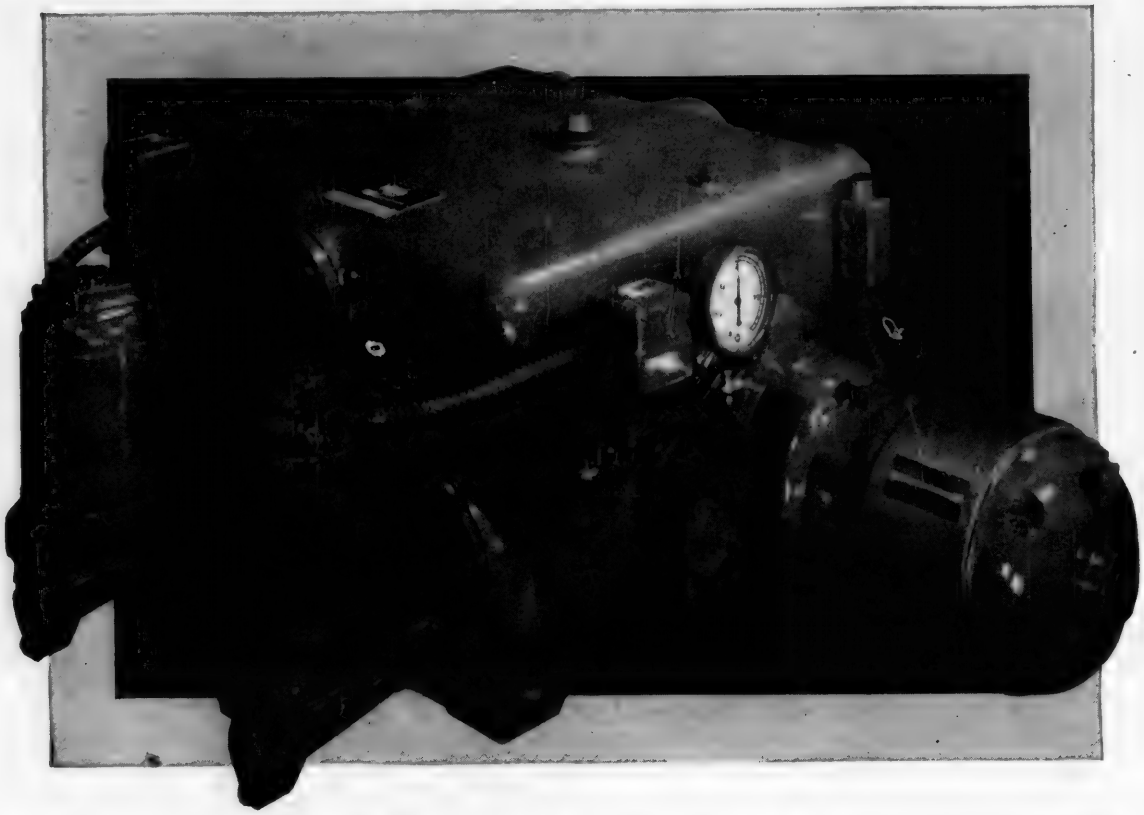

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Designed and manufactured by the organization that made the Jennings Manifold Heating Pump standard of the Heating Industry, the new CSM incorporates every desirable feature architects, engineers, owners and operators have sought. Employing separate air and water pump elements, each with its own motor and each independently controlled by its own automatic switch, the capacities and arrangement may be widely varied to meet job conditions. For the first time, the engineer has the choice of realistic water and air capacities required for rapid system response without wasteful overheating.

These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

- Increased air capacity induces rapid system response without wasteful overheating.
- Separate air and water pumps individually selected to meet actual job requirements.
- Control system that operates individual pumps only when needed.
- Flexibility permitting addition of radiation without changing basic pump installation.
- Low, low, return line connection.

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Fig. 1. Before and after fume control. At left is electric steel melting furnace without fume control operating with roof raised slightly during oxygen lancing. Photo at right shows same furnace and same operation but with roof-mounted hood and fume control system installed at the Electric Steel Foundry Co. in Portland, Oregon. Wheelabrator Corp.

CONTROL OF FUME

from Electric Steel Melting Furnaces

R. T. PRING

How special hoods and gas cleaners can be applied to control both indoor and outdoor air pollution by discharge of electric steel melting furnaces is covered in a 2-part article of which this, Part 1, deals with various hood forms.

RECENTLY, public concern and consequent enactment of air pollution code restrictions have focused attention on the electric steel melting furnace as a common source of air pollutants. Associated with the use of the arc for melting scrap is the evolution of gases and fine solid particles in varying amounts throughout all phases of the melt cycle.

Without ventilation, escaping contaminants may be dissipated through the melt shop to the outdoors. In some cases, local exhaust ventilation has been applied and discharged directly to atmosphere through a stack. In both instances, an air pollution problem is created.

Figure 1 illustrates an electric furnace operating before and after installation of a fume control system. The evolution of gases from the melt and the rapid expansion of air infiltrating the furnace create a positive pressure which forces the escape of hot, flaming gases through electrode openings. Intermingled with the escaping gases are substantial concentrations of fume particles, mostly oxides of iron, alloying metals, and trace impurities. During certain phases of the heat (i.e., particularly during melt-down), a certain amount of dust from rusty or dirty scrap is dispersed.

During the boil and oxygen lancing periods of the furnace cycle, there is a sharp increase in the amount and temperature of effluents. Further, the rate of power input to the furnace and the production rate have a direct bearing on the evolution of fume and gas.

In some of the larger arc furnaces, self-baking electrodes create an additional source of contamination in the unburned tarry matter volatilized by the heat.

Nature of Contaminants

While quantitative data are lacking, the following gases may be released during the electric furnace melting of carbon steel:

Principal Constituents	*Possible under Certain Conditions*
Nitrogen	Ozone
Carbon Dioxide	Oxides of Nitrogen
Oxygen	Hydrogen
Carbon Monoxide	Hydrogen Sulphide
Water Vapor	Hydrochloric Acid
Sulphur Dioxide	Hydrofluoric Acid
Sulphur Trioxide	Silicon Tetrafluoride
Vaporized Hydrocarbons	Ammonia, Acetylene

From furnaces in which a reducing atmosphere is maintained, escaping gases contain combustibles that undergo rapid combustion upon contact with room air. Oxidation is seldom complete, however, and carbon monoxide continues to exist in minor concentrations

R. T. Pring, a native of Massachusetts, graduated in chemical engineering from Tufts University. He then did graduate study in industrial hygiene at Harvard School of Public Health. After fourteen years with Kennecott Copper Corp. as director, Industrial Hygiene Department, and ten years as technical director, Dust and Fume Control Division, Wheelabrator Corp., he became, early in 1960, manager of dust collector sales, Dracco Division, Fuller Company. He is a registered professional engineer, both chemical and mechanical.

after the gases are cooled. Fortunately, the gaseous portions of the effluent from the steel melting furnace are not considered by most to be factors in atmospheric pollution.

The extremely fine fume and dust particles escaping with the gases will range in concentration from 0.25 to 3.5 grains per standard cubic foot and, in quantity, from four to thirty pounds per ton of metal poured. In a cold change furnace, the lowest particle size and solids emission rate are associated with clean scrap and low melting rates.

Tables 1, 2, 3, and 4 contain data on the composition of the charge and discharge from electric furnaces.

Solid contaminants from the arc furnace melting of steel are characterized by extremely fine particle size. A summary of the meager published data on particle size of electric steel furnace fume is contained in Table 5. Technical difficulties in accurately determining particle sizes in the range encountered, plus expected

TABLE 1—TYPICAL DATA ON FURNACE CHARGE AND EMISSION

(Fume collected by shell evacuation and electrostatic precipitation from three arc furnaces casting ingots, one at 50 tons and two at 75 tons)

Typical Charge	Percent
Fluxes, Carbon and Ore	5
Turnings and Borings	7
Home Scrap	20
No. 2 Baled Scrap	25
Miscellaneous Scrap (auto, etc.)	43
Typical Dust Emissions	
Silica	2
Alumina	3
Iron	25
Lime	6
Zinc Oxide	37
Magnesium Oxide	2
Copper Oxide	0.2
Manganese Oxide	4
Phosphorus Pentoxide	0.2
Sulphur Trioxide	3
Particle Size, Microns	
0- 5	71.9
5-10	8.3
10-20	6.0
20-44	7.5
Over 44	6.3
Specific Gravity	(3.93)

Coulter, R. S., *Iron Age*, Jan. 14, 1954

TABLE 2—CHEMICAL ANALYSIS OF FUME SAMPLES

(Filtered from five alloy and stainless heats during shell evacuation test by Firth Sterling, Inc.)

Analysis for	Percent by weight
Fe_2O_3	23.95
FeO	9.66
CaO	15.41
MgO	15.25
Soluble Alkalis	11.25
Cr_2O_3	8.77
SiO_2	3.76
MnO	2.75
C	1.60
MoO_3	.95
S	.64
NiO	.62
V_2O_5	.51
Al_2O_3	.47
CO_3O_4	.08
TiO_3	.05
N_2	.014
P_2O_5	Tr.
Moisture	.90
Ignition loss (probably carbonates)	.35

Santulis, M., and Texter, A. V., unpublished, Firth Sterling, Inc.

TABLE 3—QUALITATIVE SPECTROCHEMICAL ANALYSIS AND CONCENTRATION ESTIMATES OF DETECTED CONSTITUENTS

(Based on three typical samples of fume removed from hoppers of cloth filters.)

Element	Plant A	Plant B	Plant C
	Concentration Range, Per Cent		
Iron	5 to 50	Major Const.	Major Const.
Calcium	3 to 30	0.05 to 0.50	0.05 to 0.50
Silicon	0.10 to 1.00	2.0 to 20	2.0 to 20
Zinc	0.01 to 0.10	0.30 to 3.0	0.05 to 0.50
Manganese	0.50 to 5	0.20 to 2.0	0.20 to 2.0
Magnesium	0.50 to 5	0.010 to 0.10	0.005 to 0.05
Sodium	0.50 to 5		0.010 to 0.10
Chromium	0.30 to 3.0	0.5 to 0.50	0.10 to 1.00
Nickel	0.05 to 0.50	0.02 to 0.20	0.05 to 0.50
Aluminum	0.05 to 0.50	0.20 to 2.0	0.05 to 0.50
Lead	0.05 to 0.50	0.20 to 2.0	0.01 to 0.10
Molybdenum	0.05 to 0.50	0.005 to 0.05	0.005 to 0.05
Copper	0.02 to 0.20	0.03 to 0.30	0.03 to 0.30
Tin	0.01 to 0.10	0.01 to 0.10	0.01 to 0.1[illegible]
Titanium	0.0005 to 0.005	0.01 to 0.10	0.01 to 0.1[illegible]
Vanadium	0.005 to 0.05	0.001 to 0.01	0.01 to 0.10
Bismuth	0.005 to 0.05		
Strontium	0.005 to 0.05		
Cobalt	0.0005 to 0.005	0.003 to 0.03	0.001 to 0.01
Silver	0.001 to 0.01	0.0005 to 0.005	0.0005 to 0.005
Cadmium	0.001 to 0.01	0.003 to 0.03	0.0005 to 0.005
Potassium	0.30 to 3.0		

Wheelabrator Corp.

TABLE 4—QUALITATIVE TESTS FOR CERTAIN IONS IN FUME SAMPLES

(Collected from hoppers of cloth filters.)

Ions	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F
pH, (approx.)	5-6	5-6	5-6	5-6	5-6	5
Chlorides	yes	yes	yes	yes	yes	yes
Ammonium (NH_4)	trace	yes	yes	yes	yes	yes
SO_4	trace	yes	yes	trace	yes	
Sulfides	yes	?	trace	?	trace	
CO_3	no	no	no	no	yes	yes
SO_3	no	no	no	no	yes	

Wheelabrator Corp.

variations from furnace to furnace, may explain the lack of agreement among the various values given.

Health Aspects

It is still common practice to permit contaminants from arc furnaces to escape into the shop where they rise above the working area and accumulate under the roof. Dependence is placed on natural- and mechanical-draft roof ventilators or monitor louvres to exhaust the gas and solids at a rate at least sufficient to maintain equilibrium between the rate of dispersal and the rate of evacuation of the contaminants. When this equilibrium breaks down, as it will under adverse atmospheric conditions, the pall of "smoke" hangs lower in the building to the point where visibility at eye level is noticeably affected. This creates a definite safety hazard, particularly with respect to overhead crane operations.

Although there is no published record of disabling health injury caused by the inhalation of contaminants from the electric furnace melting of steel[1], oxides of alloy metals (manganese, nickel, vanadium, silicon, etc.) and other elements which may be present as impurities in the charge (lead, zinc, cadmium, etc.) have, in other circumstances, been known to affect health after prolonged exposure to high concentrations. Ordinary care in the steel furnace shop to prevent the prolonged accumulation of these substances in confined spaces is deemed sufficient protection against demonstrable health injury.

Of the gaseous compounds emanating from the arc furnace, carbon monoxide can exist (under adverse circumstances) in sufficient concentrations to produce headaches, gastric disturbances, and irritability in workers exposed during the normal work day. General ventilation of the shop by natural or mechanical draft is usually adequate to control carbon monoxide concentrations to a safe level.

Generally, it may be said that the effective removal of arc furnace effluents is a matter of comfort, safety, and employee morale.

[1] Siderosis, the presence of nodular deposits of iron oxide in the lungs, has been frequently encountered among arc welders, but it is doubtful that siderosis can result from breathing-zone concentrations of iron oxide to which electric furnace operators are exposed.

TABLE 5—ELECTRIC STEEL FURNACE FUME PARTICLE SIZE DATA

(Summary of published data.)

Source	Median Size Microns	Percent by Weight Below		
		0.5 Microns	3.0 Microns	5.0 Microns
Los Angeles study[1]	—	95	100	—
W. Coast Steel Plant[2]	—	—	—	71.9
Firth Sterling, Inc.[3]	1–3	—	—	—
ASME report[4]	—	90	—	—
McLouth Steel Corp.[5]	—	—	—	+70

[1] Allen, Viets and McCabe, U.S. Bureau Mines I.C. #7627 (1952)
[2] Coulter, see footnote, Table I
[3] See footnote, Table 2
[4] Kane, J. M., ASME Process Industries Div., Pittsburgh Regional Conference (1950)
[5] Peterson, H. W., *AIME Electric Furnace Steel Proceedings*, 1956

Fig. 2. Appearance of stack effluent without gas cleaning equipment. This is a pilot installation to investigate shell evacuation of small electric steel furnaces. Photo taken during oxygen lancing. Firth Sterling, Inc.

Air Pollution Codes

Where local exhaust ventilation is applied without gas cleaning equipment, the air pollution problem is merely transferred from within the shop to the outside. (Figure 2.)

Frequently, the mass rate of emission (in pounds per hour) may be well within existing air pollution code restrictions; however, extremely fine particle size can result in a conspicuous effluent exceeding limitations on opacity. During oxygen lancing, emissions may exceed both opacity and weight restrictions.

Nearly every industrial center has enacted regulations limiting the discharge of industrial contaminants to atmosphere. The form of the restriction and its stringency vary from city to city.

Perhaps the most acute atmospheric pollution problem existing today in this country is in the southern California area where topographical and climatic conditions, combined with rapid industrial growth, have necessitated the adoption and enforcement of detailed and stringent codes. The rules and regulations of the Los Angeles County Air Pollution Control District have been copied in more or less detail by surrounding counties in southern California and form the basis for the ordinance presently under consideration in the San Francisco area. The Los Angeles Code includes the following:

Rule 50. Ringelmann Chart. A person shall not discharge into the atmosphere from any single source of emission whatsoever any air contaminant for a period or periods aggregating more than three minutes in any one hour which is:

A. As dark in shade as or darker than that designated as No. 2 on the Ringelmann Chart, as published by the United States Bureau of Mines, or

B. Of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in subsection (A) of this rule.

Rule 51. Nuisance. A person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health or safety of any such persons or the public or which cause or have a natural tendency to cause injury or damage to business or property.

Rule 54. Dust and Fumes. A person shall not discharge in any one hour from any source whatsoever dust or fumes in total quantities in excess of the amount listed in .... (a table of allowable emission rates correlated to process weights is included in the regulation—see Table 6).

Air pollution control equipment which meets the weight restrictions of Rule 54 may still operate in violation because of the limitations on opacity imposed by Rule 50. The opacity problem is a serious one in connection with electric steel furnace operations because of the extremely fine fume particles.

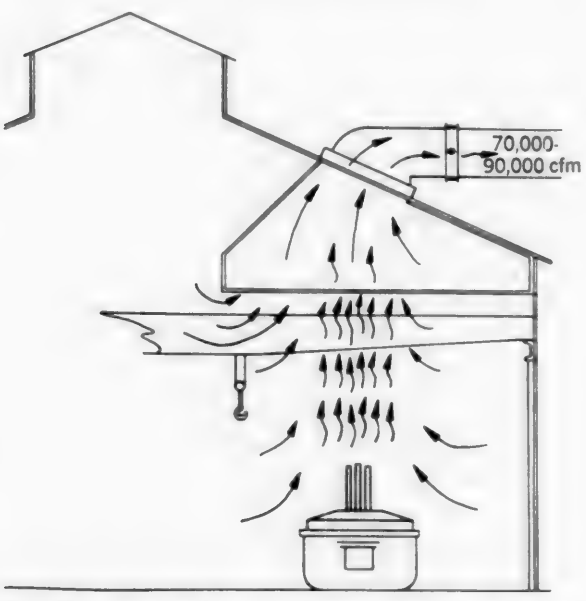


Fig. 3. Diagram of typical canopy-type hood above craneway for carrying away electric furnace effluents. Wheelabrator Corp.

TABLE 6—PROCESS WEIGHTS VS. ALLOWABLE HOURLY EMISSIONS.

(Rule 54 of the Los Angeles County Air Pollution Code)

Process Wt.	Maximum Disch.	Process Wt.	Maximum Disch.
Pounds Per Hour			
50	.24	3300	5.36
100	.46	3400	5.44
150	.66	3500	5.52
200	.852	3600	5.61
250	1.03	3700	5.69
300	1.20	3800	5.77
350	1.35	3900	5.85
400	1.50	4000	5.93
450	1.63	4100	6.01
500	1.77	4200	6.08
550	1.89	4300	6.15
600	2.01	4400	6.22
650	2.12	4500	6.30
700	2.24	4600	6.37
750	2.34	4700	6.45
800	2.43	4800	6.52
850	2.53	4900	6.60
900	2.62	5000	6.67
950	2.72	5500	7.03
1000	2.80	6000	7.37
1100	2.97	6500	7.71
1200	3.12	7000	8.05
1300	3.26	7500	8.39
1400	3.40	8000	8.71
1500	3.54	8500	9.03
1600	3.66	9000	9.36
1700	3.79	9500	9.67
1800	3.91	10000	10.0
1900	4.03	11000	10.63
2000	4.14	12000	11.28
2100	4.24	13000	11.89
2200	4.34	14000	12.50
2300	4.44	15000	13.13
2400	4.55	16000	13.74
2500	4.64	17000	14.36
2600	4.74	18000	14.97
2700	4.84	19000	15.58
2800	4.92	20000	16.19
2900	5.02	30000	22.22
3000	5.10	40000	28.3
3100	5.18	50000	34.3
3200	5.27	60000	40.0
		or more	

Air pollution codes in other areas may limit the allowable discharge of solids to atmosphere to 0.50 to 0.85 pounds solids per 1000 pounds gas (usually corrected to 12% carbon dioxide). This type of restriction is quite easily met by several available types of gas cleaning equipment; however, opacity restrictions, when present, will generally be the criterion as to compliance with the code.

Furnace Ventilation

Available methods of removing contaminants issuing from electric steel furnaces comprise:

(1) General building ventilation by natural convection or mechanical draft.

(2) Mechanical ventilation through canopy hoods situated above or under craneways (Figure 3).

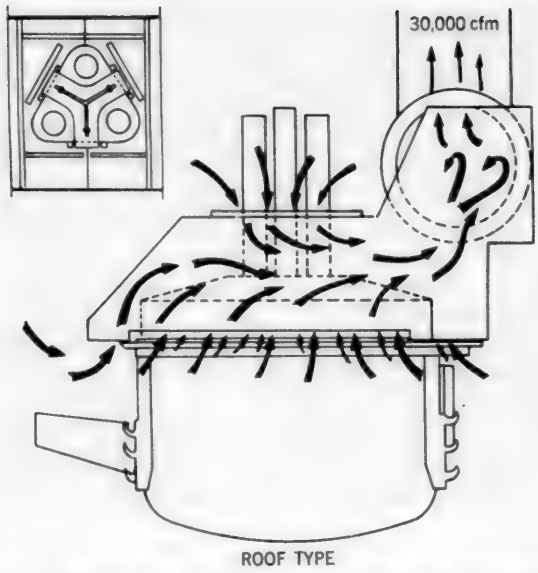


Fig. 4. Diagram of roof-mounted exhaust hood ventilating an arc furnace. Wheelabrator Corp.

(3) Local exhaust hoods mounted directly on the furnace roof (Figure 4).

(4) Direct evacuation of the furnace through a shell tap (Figure 5).

General Ventilation: Hot gases and fume particles rise from the furnace by convection and, under ideal weather conditions, may be vented directly to atmosphere through roof openings. The quantity of contaminated air which must be thus removed is greatly increased by the entrainment of considerable quantities of secondary air. Figure 6 illustrates what can happen if equilibrium breaks down between the quantity of rising contaminated air and the capacity of the available openings to the outdoors.

The installation of mechanically-powered roof fans will reduce slightly the critical effect of outdoor weather conditions; however, even these devices are subject to the effect of building cross drafts, building suction from miscellaneous exhaust systems, and the

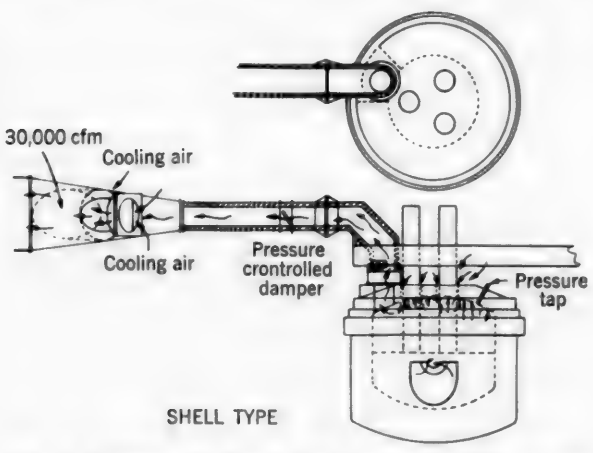


Fig. 5. Diagram of direct shell evacuation for electric furnace fume control employing tempering air for cooling. Gas volumes shown in Figs. 3, 4, and 5 are relative. Wheelabrator Corp.

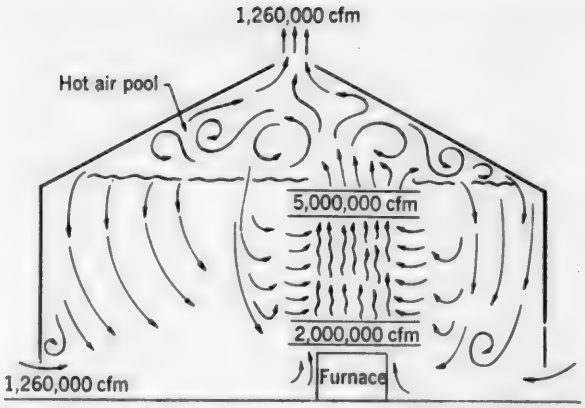


Fig. 6. Illustrating air motion where roof ventilator capacity is lower than air flow rates set in motion by heated process. Effect of conditions of this example is to force a downward flow of 5 million minus 1.26 million cubic feet of air per minute thus contaminating lower levels with air from the overhead pool. (Hemeon, W.C.L., Plant and Process Ventilation, The Industrial Press, N.Y.C.)

difference in air density between the contaminated shop air and the outside atmosphere.

Canopy Hoods: The use of canopy-type exhaust hoods located over electric steel furnaces has met with considerable favor in some quarters because this type hood is completely independent of the furnace and its auxiliary gear. The canopy hood may be located above the craneway or may be designed to swivel out of the way beneath the craneway. In both cases, the correct proportions may be determined from Fig. 7 which relates the degree of overhang of the hood to its height above the source of contaminants. An effective canopy hood is, therefore, quite large in comparison to the plan area of the furnace itself and requires two to three and one-half times the air volume used with the furnace-roof-mounted hood. Regardless of the capacity provided, the performance of the canopy hood may be adversely affected by building cross drafts which carry the contaminants beyond its zone of influence. Nevertheless, the canopy hood, when properly designed, can be reasonably effective. A typical installation is illustrated in Figure 8.

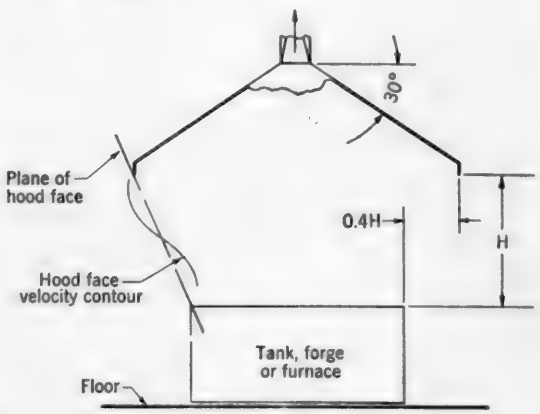


Fig 7. Recommended proportions for canopy hood. (After Alden, Design of Industrial Exhaust Systems, The Industrial Press).

Fig. 8. Canopy-type hoods above two 11 ft diameter furnaces melting special alloy steels. The furnace gases and secondary air are passed through 100,000 cfm capacity, mechanically-shaken, tubular cloth filter using Orlon bags. Wheelabrator photo of Joslyn Steel Corp., Fort Wayne, Indiana.

Furnace-Roof-Mounted Hood: Applying the principles of true local exhaust ventilation, the roof-mounted furnace hood fits closely around the area of contamination and is supported by the roof-lifting beams independently of the roof ring itself. There are three types:

(1) Two-piece construction plus takeoff box often supported from roof ring (generally obsolete).
(2) Built-in sections encompassing entire area of roof and supported from roof-lifting beams (Figure 9).
(3) Relatively small center section encompassing electrodes only, used in conjunction with annular slot manifold and baffle around shell flange and boxes over spout and doors, all connected by duct work (Figure 10).

A properly designed roof-mounted hood does not interfere with the inspection and operation of the furnace and requires only a few minutes' work whenever

Fig. 9. Shop pre-assembled furnace hood for roof-mounting (Type 2). Wheelabrator Corp.

Fig. 10. Type 3 roof-mounted furnace hood. Small center hood ventilates electrode area. Peripheral duct traps contaminants escaping around shell flange. Pangborn Corp.

it becomes necessary to change a furnace roof. Adequate vertical clearance between furnace cooling glands and the hood top is desirable to prevent damage from impingement of flaming gases on the hood center section. Being supported independently of the roof ring, the hood can swing aside with the roof-lifting mechanism and the spent roof removed from the furnace by overhead crane. With the provision of adequate ventilation capacity and allowance for thermal expansion between various sections of the hood, early objections to this type of ventilation have been eliminated.

The roof-mounted hood serves to carry away fume and gases without undue effect on the furnace atmosphere and internal gas pressure. The effect of Type 3 above is probably somewhere in between this principle and that of the direct shell tap. C. W. Finkl, in AIME Electric Furnace Steel Proceedings, 1956, shows that the Type 2 hood exerts no measurable influence on internal furnace pressures.

Hood Types 1 and 2 are generally of carbon steel construction with stainless steel inserts surrounding the electrodes plus a stainless "wedge" across the top to break any magnetic field. Type 3 usually employs stainless steel for the electrode hood with replaceable stainless steel top. The remaining portions of this device may be fabricated from either carbon or stainless steel.

All three types of roof-mounted hoods may be equipped with a sliding flange joint between the movable hood and the stationary duct to permit tilting the furnace and swinging out the furnace roof. Where continuous ventilation during pouring and slagging is desirable, swivel-slip joints between hood and stationary duct may be provided. Even with continuous ventilation of the furnace, there is no ventilation of the ladle during pouring unless auxiliary hoods and additional ventilation capacity are provided.

Conclusion in Part 2, next month, will describe investigation of systems for direct shell evacuation and show how to compute required ventilation rates for various fume control arrangements applicable to electric steel furnaces.

Residential Snow Melting Systems

WARREN S. HARRIS
Professor of Mechanical Engineering
University of Illinois, Urbana, Ill.

Operating data from a snow melting system installed for test purposes at the I-B-R Research House, in Urbana, Ill., have led to some sound recommendations for the design and installation of effective and economical residential snow melting systems.

THE ADVANTAGES OF SNOW MELTING IN THE SIDEwalks around banks, stores and other commercial buildings are well known and many such installations have been made and are now in operation. Popular opinion is that this is a luxury beyond the reach of the home owner and, hence, domestic snow melting installations have received little attention. Actually, for a nominal installation cost snow melting can be installed in the driveway and walks around homes having hot water heat and the operating cost may be comparable to the cost of snow removal by manual means.

A snow melting system is simply panel heating that is located in the walk or driveway. An anti-freeze solution is used to prevent freezing during periods when the system may not be in use. Heat is received from the house heating boiler through a heat exchanger which, in appearance and method of operation, resembles an indirect water heater.

A residential snow melting system should have the following attributes:

1. It should be low in first cost.
2. It should be low in operating cost.
3. It should keep the walk completely free of ice, snow and slush at all times.
4. It should not require the attention of the occupant of the house.
5. It should be so designed that the boiler need not be oversized in order to carry the combined loads of house heating and snow melting.
6. The operation of the snow melting system should not interfere with house heating performance.

In order to secure operating data on a residential snow melting system which would lead to the eventual publication of an installation guide for residential systems, the Institute of Boiler and Radiator Manufacturers included in the research program they sponsor at the University of Illinois a study of an experimental installation at the I-B-R Research Home.

The experimental installation consisted of ¾-inch iron pipe laid on 12-inch centers in both the sidewalk and driveway. The concrete slab was 5 inches thick and the coils were so placed that there was approximately 2 inches of concrete covering the pipes and another 2 inches between the pipes and the gravel fill. All piping in the concrete slab was of welded construction. No insulation was used at either the edges or under the concrete slab.

The same boiler used to heat the I-B-R Research Home supplied heat for snow melting through a heat exchanger. The entire snow melting system was filled with an anti-freeze solution to prevent freezing during periods when the system might not be in use.

The controls were so arranged that the system could be operated manually or by thermostat. Under manual operation, the pump circulating fluid between the heat exchanger and the snow melting coils was turned on whenever operation was desired and allowed to operate continuously until manually turned off. The thermostatic control system consisted of a thermostatic element, located in the walk, which turned on the circulating pump at any time the walk temperature dropped to about 35 deg F, and turned it off when the temperature of the walk was raised to about 40 deg.

The use of pipe coils embedded in sidewalks and driveways for snow melting presents many possible arrangements of coil spacing, depth of bury, coil size, and use of insulation under the slab. The test installation permitted observations on only one configuration. In order to investigate the effect of other design vari-

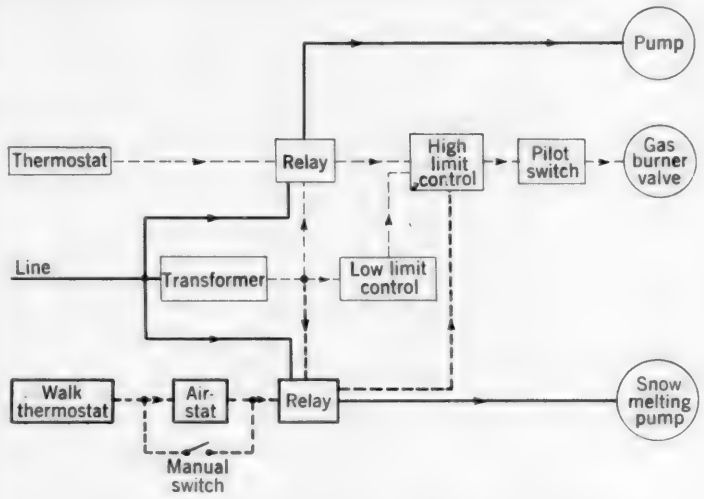


Fig. 1. Walk thermostat is set to operate snow melting pump whenever walk surface temperature is below 35 deg F. Air-stat prevents operation of snow melting system if outdoor temperature is below 15 deg unless manual switch is closed. If manual switch is closed, walk thermostat controls the operation of pump in snow melting system regardless of outdoor temperature. The burner in boiler will be in operation at any time the snow melting system is operating and boiler water temperature is less than setting of the high limit control on house heating system.

ables on rate of pick-up, heat input, and slab surface temperature, a method of numerical analysis was employed. The panel arrangements studied by the mathematical approach are listed in Table 2. Since the first arrangement was the same as that used in the test installation it was possible to compare results obtained by the mathematical approach with those obtained by actual test.

Data collected during the five winters when the system was in operation indicated that the thermostatic control was far superior to manual control. Thermostatic control prevented the collection of snow or slush on the walk at all times without attention on the part of the home owner, and did this at no greater operating cost than obtained with manual operation.

Snow melting systems are slow to respond and, therefore, with manual control it was necessary that the system be in operation long enough to raise the walk surface temperature above the freezing point to prevent snow from starting to accumulate on the walk. This required as much as two hours advance operation. If snow collected on the walk prior to the start of the snow melting system, the system could never completely catch up with the snow fall rate and, as a result, some slush remained on the walk until snowfall actually stopped.

No studies of installation costs were made during the investigation, but installation costs have been estimated at from $1.00 to $3.00 per square foot of snow melting area.

Operating costs of the test system using thermostatic control were approximately $18.00 per year or about 6¢ per year per square foot of snow melting area. These operating costs were based on the use of gas in the boiler with gas costing 6.5¢ per therm, and were obtained by first operating the house heating system without the snow melting system attached so as to obtain a record of daily fuel consumption required for house heating for all outdoor air temperatures. The snow melting system was then attached to the house heating boiler and the tests repeated. The difference in fuel consumption with and without the snow melting system in operation represented fuel consumption chargeable to the operation of the snow melting system. Total fuel consumption for the season charged to snow melting operation was the sum of the products of daily fuel consumption chargeable to snow melting for each average outdoor temperature and the number of times per year that outdoor temperature occurred. Table 1 was obtained in this way using actual test observations for the system installed at the I-B-R Research Home. During these tests the snow melting system was thermostatically controlled so as to maintain a walk

TABLE I—FUEL CONSUMPTION AND COST CHARGEABLE TO OPERATION OF SNOW MELTING SYSTEM

Average Outdoor Temperature, Deg F	Average No. of Days per Year	Cu ft of Gas per Day	Per Season	
			Cu ft of Gas	Cost at 6½c per Therm
—10 to —5	0.2	1570	314	$0.20
— 5 to 0	0.4	1390	556	0.36
0 to 5	0.8	1210	968	0.63
5 to 10	2.2	1010	2,222	1.44
10 to 15	4.6	820	3,772	2.45
15 to 20	7.6	640	4,864	3.16
20 to 25	13.6	450	6,120	3.98
25 to 30	25.4	260	6,604	4.29
30 to 35	33.8	80	2,704	1.76
35 to 40	30.0	0	0	0
40 to 45	23.4	0	0	0
		Season Totals	28,124	$18.27

Warren S. Harris received a Bachelor of Science degree in Mechanical Engineering from the University of Illinois in 1930, and a Master of Science degree in 1933. He was employed for one year in the research laboratory of Philadelphia and Reading Coal and Iron Co., and for six years by Delco Appliance Division of General Motors to take charge of its thermal research and development lab. Since 1940 he has been on the research staff at the University of Illinois in charge of the I-B-R research program.

TABLE 2—DESCRIPTION OF COIL AND PANEL ARRANGEMENTS USED IN NUMERICAL ANALYSIS

Arrangement	Depth of Bury, Inches	Coil Size, IPS	Coil Spacing on Centers, Inches	Insulation Depth, Inches
1	2	¾	12	None
2	2	¾	12	2
3	2	¾	6	None
4	2	¾	6	2
5	¾	½	6	None
6	¾	½	6	2
7	1	¾	12	None

temperature of 35 to 40 deg regardless of outdoor conditions.

It should be noted that while the daily gas consumption charged to the operation of the snow melting system was quite large at low outdoor temperatures, operation at outdoor temperatures of 10 deg and less accounted for only 15% of the total fuel consumption due to the relatively few days per year these low temperatures occurred. The main objection to allowing the snow melting system to operate at a low outdoor temperature is the increased load on the house heating boiler at a time when the house heating load is also large. Since heavy snow falls seldom occur when the outdoor temperature is below 10 deg, it may be advantageous to use an outdoor temperature control which would prevent operation of the snow melting system at these low temperatures. If such a control is used, a manual switch should be connected in parallel with it to permit operation of the snow melting system in emergencies. See Fig. 1 for details.

Numerical analysis indicated that the value of insulation under the slab depends upon the coil spacing and the depth of bury. If the depth of bury is only ¾ inch, insulation does not affect surface temperature or the required energy input per sq ft of panel area. However, if the depth of bury is 2 inches, insulation under the slab reduces the required energy input by about 12% for coil spacing of 12 inches and about 20% for coil spacing of 6 inches. Possibly there would be some economic advantage in the use of insulation if coil spacing of 6 inches is used, but the operating cost is so small that, with a 12-inch coil spacing, insulation offers no economic advantage.

Other results of the numerical analysis are shown in Table 3. It will be observed that the use of a 6-inch coil spacing and a 2-inch depth of bury provides the fastest rate of heating the walk between the coils. Table 3 shows that to obtain these relatively fast pick-up rates, excessive energy inputs are required for at least the first fifteen minutes of operation. The average house heating boiler is not capable of supplying such a high energy input to the snow melting coils and at the same time providing sufficient heat for the house. Moreover the installation cost of a system designed for quick pick-up is high, due to the additional pipe required. These reasons, combined with the fact that snow may fall when the occupants of the house are asleep or away from home (and thus the snow melting system would not be in operation when it was needed most), again suggest the use of automatic controls for truly satisfactory performance.

Most design procedures for snow melting systems provide means of calculating the energy required to melt the snow and provide for evaporation and convec-

TABLE 3—TIME REQUIRED TO HEAT SURFACE AND HEAT INPUT RATE FOR VARIOUS INITIAL WALK AND AIR TEMPERATURES

Arrangement (See Table 2)	Initial Air and Walk Surface Temperature, Deg F	Average Water Temperature — Time Required to Heat Surface to 32 Deg F, Minutes						Average Water Temperature — Heat Input Rate, Btuh per Sq Ft of Panel					
		90 Deg F		120 Deg F		140 Deg F		90 Deg F		120 Deg F		140 Deg F	
		Over Coil	Between Coil	Over Coil	Between Coil	Over Coil	Between Coil	15 Minutes After Start	200 Minutes After Start	15 Minutes After Start	200 Minutes After Start	15 Minutes After Start	200 Minutes After Start
1	0	110	+1000	32	1000	24	500	290	165	390	220	450	260
2	0	95	900	32	600	24	400	290	145	390	190	450	230
3	0	59	147	30	63	23	50	580	240	780	320	900	380
4	0	59	112	30	61	23	49	580	190	780	260	900	300
5	0	12	900	5.5	215	4.2	140	280	190	380	260	440	300
6	0	12	600	5.5	170	4.2	110	280	190	380	260	440	300
7	0	6	+1000	4.1	+1000	3.5	600	280	175	370	230	440	270
1	—20	180	+1000	52	+1000	39	810	350	200	450	255	515	295
2	—20	155	+1000	52	1000	39	650	350	175	450	225	515	260
3	—20	95	240	49	102	37	81	700	290	900	370	1030	430
4	—20	95	180	49	99	37	80	700	230	900	300	1030	340
5	—20	20	+1000	9.0	350	6.8	230	340	230	440	300	500	340
6	—20	20	+1000	9.0	280	6.8	180	340	230	440	300	500	340
7	—20	10	+1000	6.7	+1000	5.7	1000	340	210	435	270	500	310
1	+20	40	——	12	——	9	190	230	130	320	180	390	220
2	+20	36	350	12	225	9	150	230	110	320	160	390	190
3	+20	22	55	10.2	24	8.5	19	460	190	640	270	780	320
4	+20	22	40	10.2	23	8.5	18	460	150	640	210	780	260
5	+20	4.5	350	2.1	80	1.5	53	220	150	310	210	380	260
6	+20	4.5	220	2.1	64	1.5	41	220	150	310	210	380	260
7	+20	2.0	—	1.5	—	1.3	225	220	135	310	195	370	230

Fig. 2. Photo was taken one hour after snow melting system was manually turned on. When started, driveway had 1 inch of snow and surface temperature was 32 deg.

Fig. 3. This is the walk with system operating thermostatically. Photo was taken after 4-hr storm during which 5 inches of snow fell without any accumulation on walk.

tion losses from the surface of the panel, but do not attempt to estimate the losses into the ground. These ground losses are simply taken as a percentage of the calculated snow melting load and losses from the surface of the panel. Data in Table 3 include ground losses so that no additional allowance need be made.

The data included in Table 3 has been expanded into Table 4 to show the effect of outdoor temperature, rate of snowfall, and fluid temperature on panel load. Table 4 has been constructed for panel arrangement 1 only, and contains all the information required to design snow melting panels intended for thermostatic control once the design snow melting rate and outdoor temperature have been determined. This information may be obtained from the weather station in the locality, or if it is not available, a system designed to provide for a melting rate of 2 inches per hour at an outdoor temperature of 20 deg will usually be adequate.

TABLE 4—DESIGN DATA FOR THERMOSTATICALLY-CONTROLLED SNOW MELTING PANELS WITH ARRANGEMENT-1 CONSTRUCTION*

Outdoor Air Temperature, Deg F	Snow Fall Rate, Inches per Hour	Average Fluid Temperature, Deg F	Total Load, Btuh per Sq Ft of Floor Panel
20	1	90	130
		100	145
	2	110	165
		120	185
		130	200
	3	140	220
		150	240
0	1	90	165
		100	185
		110	200
		120	220
		130	240
	2	140	255
		150	275
		160	295
		170	310

* Arrangement-1 construction specifications: coil size, ¾-inch IPS; coil spacing, 12 inches on centers; depth of bury, 2 inches of concrete over top of coil.

The total area to be kept free of snow times the load indicated in Table 4 represents the total load on the heat exchanger. This assumes the losses from the mains are negligible. The rate of circulation of fluid through the snow melting system may be assumed as 1 gpm for every 10,000 Btuh load. This is based on a temperature drop of about 24 deg using a fluid consisting of equal parts of water and ethylene glycol. Manufacturers of heat exchangers can recommend the size of unit required if supplied with the rate of circulation of fluid, and temperatures of fluid and boiler water.

The friction head of a 50% ethylene glycol solution is approximately 20% greater than for water. Therefore if friction loss charts or tables for water are used to determine the friction head, the values read from the chart or table should be multiplied by 1.2 before selecting the pump.

In determining if the boiler is adequate in size to take care of the combined house heating and snow melting load, one may assume that the margin between the net rating and gross output of the boiler is available to operate the snow melting system. Furthermore, since most heavy snowfalls occur when the outdoor temperature is 10 deg or above, the full house heating load will not occur concurrently with the maximum snow melting load except in those localities where the winter outdoor design temperature for heating is 10 deg or higher. The following formula has been found satisfactory for determining the required boiler size:

$$B_h = (H \times 60/\Delta t) + S$$

Where

B_h = Gross boiler output
H = Design house heating load, in Btuh
Δt = Design indoor-outdoor temperature difference for house heating. In no case use Δt less than 60 deg.
S = Calculated snow melting load in Btuh determined as described earlier in article.

The Institute of Boiler and Radiator Manufacturers is preparing an installation guide following the procedure outlined in this article. This Guide will contain detailed instructions for each step of the design and installation procedures which should enable the average contractor to design and install residential snow melting systems in conjunction with hydronic heating.

STORM SEWER DESIGN

for industrial and office sites

With increasing migration of industry and offices from urban to suburban and rural areas, construction projects tend to include design of outside storm sewer systems serving the buildings, parking lots, and extensive lawn areas associated with these modern installations.

Although larger and more complicated sites usually require the services of a specialist in this field, the mechanical designer often finds himself, for reasons of time or economy, doing the work of the hydraulic engineer in addition to the usual interior drainage piping. This Reference Section was written for him.

January, 1961

WILLIAM W. FANNON

Design Engineer
Elson T. Killam Associates
Millburn, New Jersey

AIR CONDITIONING, HEATING AND VENTILATING's
REFERENCE SECTION

WHEN DESIGNING A STORM DRAINAGE SYSTEM FOR THE site of an office building, factory, or laboratory, knowledge of several fields is required: hydraulics, hydrology, soil mechanics, structural strength of pipes and simple structures, and open channel flow. The designer should be aware of the several disciplines and be able to apply intelligently the basic principles involved in each field. The objective is preparation of plans and specifications for a storm sewer system which will convey all excess water from the site to some safe and convenient discharge point. To accomplish this purpose, it is necessary that he determine the probable maximum rate of runoff and the likely distribution of this runoff. Then there remains only to provide a satisfactory hydraulic channel (usually a pipe) to carry the expected flows. The basic problem seems simple enough when thus put in its most elementary form, but it is often more difficult in practice due to the inability to forecast accurately many of the controlling factors.

Arrangement of piping in a storm sewer system is simpler than the complex piping layouts found within the walls of the buildings on the site. The end result of the design procedure is a simple arrangement of sewer lines running between manholes and inlets. In fact, simplicity of design, economy in number of lines, smoothness of slopes, and uniformity of spacing of structures can be taken as an indication of the skill and care of the designer. Difficulties are introduced into the work by the large number of unknown, and unknowable, design factors. The exact amount of rainfall can never be determined, hence, a more or less artificial "design storm" must be used. Carrying capacity of pipes, normally predictable, is complicated in storm sewers by the possibility of partial blockage by debris. Hydraulic conditions at the point of discharge are highly variable. Percentage of rainfall that actually runs over the ground and enters the storm sewers is the most variable factor of them all; it varies with time of year, preceding rainfall conditions, nature of the soil, type of improvements on the site, slope of the ground, and unnumbered other features. These factors the designer must balance out to obtain an economic and adequate storm sewer system for the site.

Preparation of the design for a storm sewer system on a single site does not warrant a complete study of the many factors determining the "design storm" for that site, nor does it allow for time consuming trial-and-error methods of arriving at the most economic storm sewer layout. A satisfactory substitute for these methods is a series of generalized design procedures, tables, and curves, developed to simplify the work without losing sight of the basic principles involved. The exact nature of these design aids vary from person to person. Each man has his own pet techniques and design factors, yet all follow the same general method of design. The following is a general explanation of the principal points involved in this basic method of design, together with an explanation of some of the curves and design forms normally used. A brief description of the underlying theory is also included to aid in the application of the basic ideas to specific cases.

Procedures presented here are theoretical. Many modifications, short cuts, or omissions may be made, depending upon the scope of the project and the experience of the designer. However, the designer should be familiar with the complete procedure so that he will be less likely to skip or slight some important step and so cause trouble later in the design or, still later, during construction.

I. INVESTIGATION OF OUTLETS

Possible points of discharge must be located and the probable water level under storm conditions at these various discharge points estimated. Storm sewers can be expected to flow full, with perhaps a foot or two added as a safety factor to allow for possible surcharge of the existing pipe under storm conditions. Smaller streams rarely have any appreciable backwater flooding, so that it is not necessary to assume any depth of flow greater than the top of their banks. Greater depths of floods should be expected, however, on larger rivers. The designer should determine from local authorities the depths of previous large floods and should assume a flood depth at least two or three feet greater than the largest flood of record. When the point of discharge is simply a headwall discharging onto dry ground, it is necessary simply to determine the elevation of locations that provide favorable discharge conditions with minimum possibilities of future erosion and maximum opportunity for the discharged water to spread out over the ground, thus eliminating possible damage to downstream properties.

When first estimates of design discharge water levels for the various discharge points under consideration have been determined, they can be compared with the ground elevations on the site. The lowest point on the site must be high enough above the design discharge level to allow for a reasonable slope in the pipes between the site and the discharge point and to provide sufficient cover over the pipe at all points along its length. This comparison of elevations will quickly indicate the feasibility of the various discharge points and will also pinpoint potential flooding spots on the site. If the designer does discover that there is a serious possibility of back flooding from the discharge point to the site, or if there is simply not enough elevation difference to allow for the installation of a storm sewer, it may be necessary to raise the elevation of the grades and buildings, or even abandon the site entirely.

Occasionally, an obvious point of discharge does not present itself at first glance. Existing storm sewers may be too small, there may be no streams or water courses close enough to be of any practical use, and

surrounding development may prevent dumping of storm waters on the surface. In that case, the designer should find out what is the existing method for disposal of storm runoff. This is usually the best clue to disposal of storm waters after the site is developed. If the flow is presently to an inadequate storm sewer, it would be well to investigate the possibility of enlarging or paralleling the existing line. This would probably be a municipal project with the owner paying a fair share of the construction costs. Another case might involve the creation or improvement of an open channel for storm water flows from the area. Larger projects might justify the cost of a long sewer line to some distant point of discharge, in which case the designer should be ready to recommend routes and sizes of the outfall. Finally, lack of an adequate outlet point may lead to the development of a retarded runoff design with maximum flows fixed by whatever capacity is available to carry flows from the site.

Very rarely is the designer faced with a site having absolutely no outlet, either existing or potential, for its storm water runoff. Such condition exists only when the ground is pervious enough to absorb the existing storm runoff; otherwise some sort of drainage pattern would have developed over the years. In this event, it may be necessary, as a last resort, to turn to the collection and ponding of storm waters in lagoons for ultimate disposal by percolation and evaporation.

2. PERMITS

Before proceeding with details of design a check of all governmental regulations that may affect the project should be made. Local plumbing codes that cover interior plumbing are not usually applicable to outside site sewers. An effort should be made to establish the difference between the two, so that the storm sewer design is not controlled by plumbing requirements, particularly minimum slopes of pipes which are normally steeper than slopes used in laying storm sewers. One way to emphasize the difference is to issue the storm sewer drawings as a portion of the site work, rather than as a part of the plumbing work.

Where the plumbing code does not govern the design of storm sewers, the designer should check to be certain that the local municipality does not have a separate set of requirements controlling the construction of private storm sewers. Requirements are more likely to exist covering the connection of private storm sewers to municipally owned lines. The local municipal engineer is the best person to contact regarding these matters.

If construction on or along a stream or river is involved, the designer should check the possibility of State regulation of such construction, particularly the flood control aspects of the work. Any permits required for road openings, sewer connections, or any other portion of the work should be checked at this time and necessary applications submitted as soon as possible, to avoid delay at the time of construction. Applications are usually submitted to the road department of the governmental body controlling the roads to be opened or the sewers to be connected. The local municipal engineer is likely to be familiar with all those involved and should be contacted for assistance.

3. STORM SEWER LAYOUT

With preliminary investigation completed, the designer is ready to start on the details of the actual design. The first step is the start of a detailed utilities site plan. The site designer will have prepared a detailed site plan showing existing and proposed buildings, roads, parking lots, and other features of the site. If the storm sewers are relatively simple in scope, it may be possible to show them on this site plan. On the other hand, even a moderately complicated sewer system will require a separate plan sheet which can also be used to show all of the other outside utilities on the site. In construction practice, sewers are normally not installed by the site contractor who does the grading and paving work. Therefore, there is no advantage in having both types of work appearing on the same sheet.

Trying to show everything on a single sheet will, more often than not, lead to unnecessary confusion. The extra work involved in the preparation of separate site utility plans is more than compensated for in the clarity achieved. Best practice is to make the utility site plan a copy of the site development plan by tracing all buildings, roads, and other improvements, but omitting all site dimensions, contours, notes, and other items not applicable to the utility work. In this way, the site development sheet can be used entirely to show construction connected with that work and can also serve as a reference sheet for the utility plan by showing distances and locations of structures. The two sheets complement each other, each showing clearly the different types of work on the site without causing confusion between the two.

The site designer will probably have established the locations of most of the drain inlets on the site as a part of his work, since these are fixed by low points in grading or in paved areas. The storm sewer designer should review these locations, checking particularly to be certain that a sufficient number of inlets have been provided along roads and in parking areas. If there is

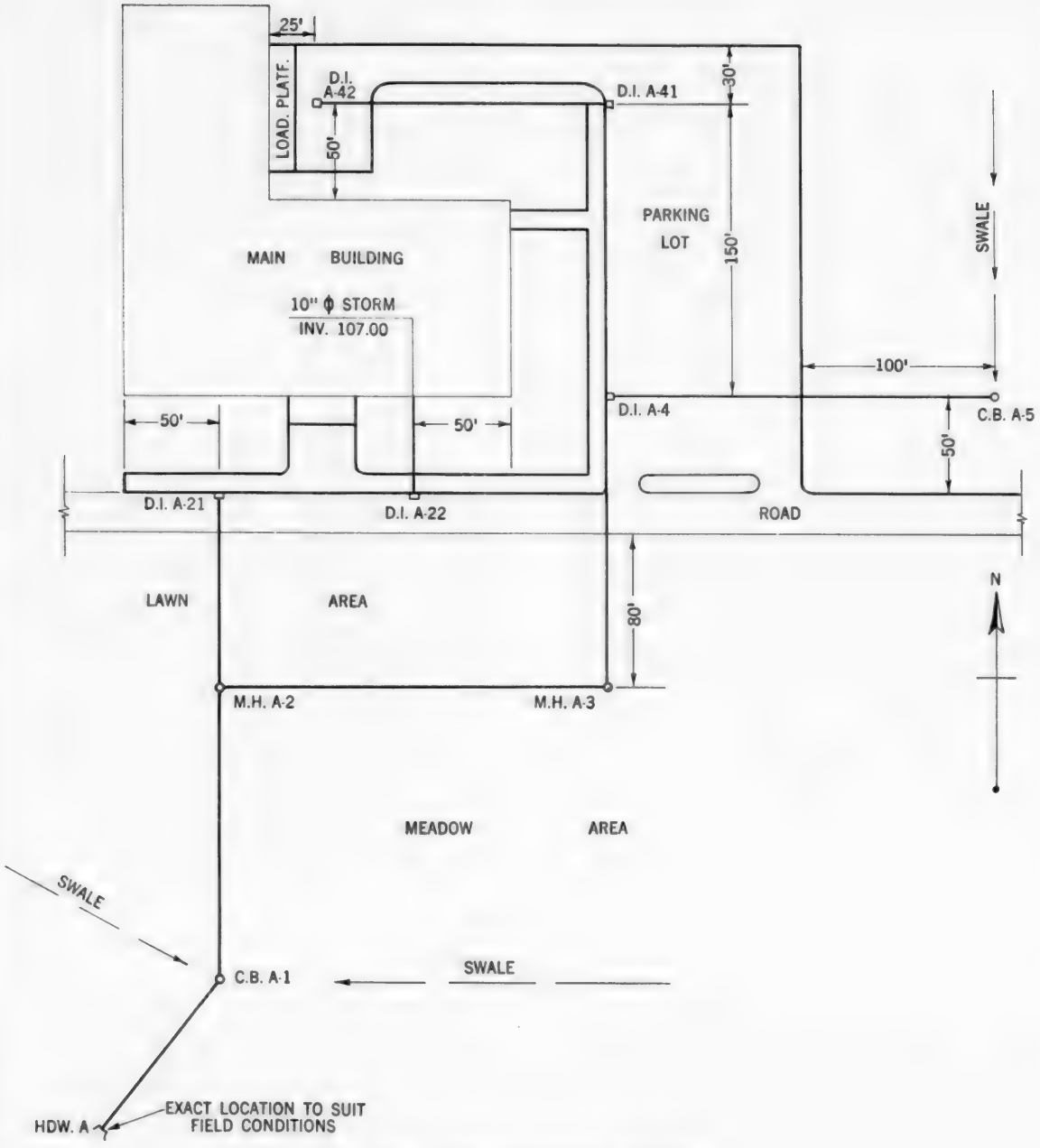


Fig. 1. Typical storm sewer site plan.

a large tributary drainage area, it is sometimes necessary to provide two inlets, side by side, in order to obtain sufficient inlet capacity. Final number and location of inlets should be determined in conference with the site designer at this time. When all these outside points that must be picked up by the storm sewer system are determined and are plotted on the utility site plan, there remain only the various building outlets. Exact locations of these can be taken from the plumbing drawings and should also be plotted on the utility site plan. A little foresight in the plumbing design can sometimes help bring these building connections out at points advantageous to the site storm sewer. With all of the pickup points thus plotted on his site sheet, the designer must next lay out the sewer lines connecting these points. (See site plan, Fig. 1, above.)

Considerable thought must be given to this layout, for several controlling factors must be considered

simultaneously. At this time it is not necessary to consider, except in a general way, sizes and slopes of the various pipes, but care should be taken to run the storm sewers in the general direction of the surface slopes. In this way, unnecessarily deep sewers will be avoided.

Low pockets in the grading often cause design difficulties and should be noted at this time for special care during design.

Storm sewer layout must be closely coordinated with the layout of the other site utilities. It is best, at this juncture, to establish the location, in plan, of all outside piping and conduits at the same time by a conference of all persons concerned with site development and utilities. Exact locations can be established for all utilities so as to avoid horizontal interferences. Sizes of manholes, junction chambers, expansion loops and underground structures should be considered when allotting space for the various lines. This procedure will greatly reduce or eliminate interferences which might otherwise not appear until completion of design or even until after construction has started.

Within the space allotted to the storm sewers, the designer should attempt to pick up all the building outlets and drain inlets plotted on his plan sheet using a minimum of piping. There are, however, several additional factors to be considered. The utility site plan should show all obstacles to pipe laying, such as retaining walls, underground tanks or vaults, ponds, or large trees which must be preserved. All such obstacles must obviously be avoided.

Another factor affecting sewer layout is that of trench settlement under paved areas. Unless a considerable amount of time, six months or more, will elapse between construction of storm sewers and placing of road pavement, it is almost a certainty that settlement in the storm sewer and other utility trenches will damage the paved surface. Although every attempt should be made to secure adequate compaction, experience has shown that some final settlement will, almost certainly, take place. Thus, good design practice dictates that storm sewer systems should, insofar as possible, not be run under paved areas. Inlets in the middle of parking areas, of course, must be connected by lines laid beneath paved areas, but it is not necessary to connect inlets located along roads with lines beneath the pavement. Pairs of inlets can be connected to a manhole a short distance off the road, and the sewer can be carried parallel to the road.

Still another factor to be considered is the ease of field layout of the storm sewer system. Running lines parallel to or perpendicular to building faces, roads, and parking lots will facilitate location and layout in the field without adding appreciably to construction costs. In addition, there is less chance of error and confusion when locations of other utilities are fixed in "slots" at certain distances from defined points, as road centerlines, edges of parking lots, or building faces.

Mindful of all these considerations, the designer makes his first trial layout of the system. Starting at the lower end, the previously investigated discharge point, the layout proceeds upstream, picking up all plotted inlets and building connections. A manhole or inlet should be provided at every junction point and change in direction. If this procedure is followed, the storm sewer system will normally develop as a perpendicular system of lines with straight runs, rather than a jumble of lines wandering from inlet to inlet without regard to surface conditions.

When this first trial layout is completed, it should be reviewed as a whole for possible savings in pipe runs. The designer should be suspicious of long, parallel runs of pipe. Normally, a single pipe will serve the same purpose. Also, any tendency of the flow from an inlet or area to be carried around in a circle, that is, to start in one direction and be reversed further down the line, should be avoided, if possible. Most often, a saving can be achieved by running initially in the final direction.

Previously noted low points in the grading should be bypassed by the main sewer, since the shallow cover might lead to construction difficulties with larger sizes of main line pipe. These low points can be drained by branch lines. Long runs that serve only to pick up one or two inlets should be investigated for possible alternate independent outlets. Any tendency to zig-zag or otherwise depart from the general perpendicular pattern should be investigated as a possible departure from one of the controlling criteria.

After making such improvements in the storm system pattern as may seem desirable, and after making such changes as may seem warranted in order to save piping, the layout can be drawn on the utilities site plan. Additional manholes may still be required at sharp changes in grade not noticeable from the site plan. Minor relocations will almost certainly be required due to changes in the site work or unforeseen interferences with other utilities, but the layout of the storm sewer system as a whole has now been substantially fixed.

4. CALCULATION OF DESIGN FLOW

Storm sewer systems are designed to carry the maximum flow from the design rainfall without surcharge or pressure on the pipes. In other words, the pipe should flow just full under design conditions. For all other, smaller, storms the pipe will flow partly full. There is, of course, the certainty that an occasional storm will be heavier than the one for which the system is designed. In that event, the pipes will be unable to handle the flow and surcharge with consequent backup in the system will necessarily occur. This design practice is permissible with relatively small systems. It does not entail those procedures which involve the use

of flow hydrographs and other refinements to ascertain distribution of flow in time and the effects of storage. Such refinements are more applicable to storm sewer studies covering an entire city than to those to be constructed on a single piece of property.

A major decision is the *storm frequency* to be designed against. A clear understanding of the meaning of the term is most important. Frequency of a given storm intensity, expressed in years, is the average number of years between occurences of a storm of this given intensity or of a greater intensity. Over a period of one hundred years there will be ten storms equal to or greater than the storm of ten-year frequency. (The term *return period* is sometimes used in place of *frequency*.) It can be understood intuitively that the probability of more severe storms increases as the design period increases. The more conservative the design, the larger the design frequency chosen.

Municipal storm sewer systems are most often designed for a storm frequency of five years, or even less. This relatively short design period is dictated by the small amount of actual damage that will occur when street inlets back up and by a reluctance to spend public money to avoid the inconvenience of minor flooding once every few years. *For the normal site being considered here, and where there are no unusual conditions, a design frequency of ten years should be used.* Where the designer feels that possible flood damage might justify greater protection, a fifteen-year period should be adopted. Before going to an even longer design period where particularly critical conditions exist, it would be wise to investigate the possibility of special protection such as dikes or emergency pumps.

Storms that cause flooding of small storm sewer systems are characterized by short, sharp periods of rainfall which occur as thunderstorms or as short periods of intense rain during longer storms. Major storms that cause flooding on larger rivers may have more total rainfall but this rainfall is distributed over a much longer period of time. The amount of runoff created by the short storms with which we are concerned is usually determined by the so-called *rational method*. See Reference No. 4 for a complete analysis of the rational method. Despite its name, the rational method employs several broad assumptions and an all-encompassing empirical coefficient in arriving at a given storm flow.

Computations take the form of the formula:

$$Q = C\,I\,A$$

Where Q is the storm discharge, cubic feet per second,

C is a coefficient, originally thought to be a ratio of runoff to rainfall but modified over the years to reflect such runoff-influencing factors as surface storage, antecedent rainfall, state of vegetation and many others. (A list of typical C coefficients is given in Table 1.)

I is the average intensity of rainfall over the critical period of the design storm, inches per hour, and

A is the drainage area, acres.

Selection of the proper value for rainfall intensity, I, requires a plot of data from a rainfall gage near the site and the assumption or computation of a critical period of time, called the *time of concentration*. The time that it takes for the entire area to start contributing to the flow at a given point is known as the time of concentration of that point. The time of concentration for an inlet, sometimes called *inlet time*, is the time it takes for rainfall to accumulate and flow over the ground to the inlet.

For the moderately sized drainage system within the scope of this article, it is usually safe to assume either a five-minute or ten-minute period for storm sewer inlets. The lesser figure will apply to parking lots and

TABLE 1—RUNOFF COEFFICIENTS

Type of Surface	Description	C
Grass	Rough grass or undeveloped ground	0.10
Grass	Average developed lawn	0.20
Grass	Sparse lawn on hard ground	0.25
Paved	Rough surface on flat slopes	0.80
Paved	Average pavement	0.85
Roof	Flat roof with provisions for standing water	0.85
Roof	All other roof surfaces	0.95
Composite	Average values for entire site area. Value depends upon relative amount of lawn area	0.55 to 0.75

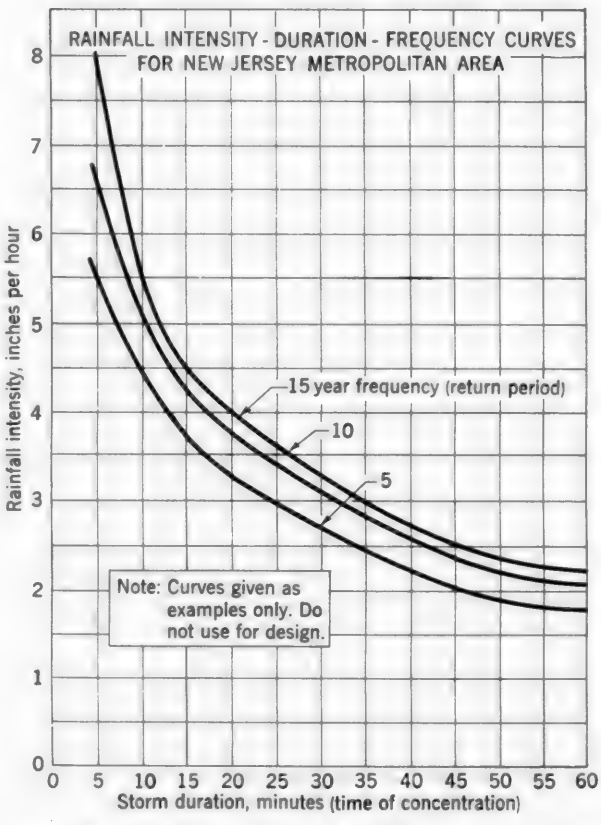


Fig. 2. Typical curves for finding rainfall intensity.

smaller plots, the greater figure to more extensive lawn areas. For more extensive drainage systems, elaborate procedures have been devised, the most direct and least time-consuming of which is given in Reference 2.

Time of concentration in the storm sewer *system* is the sum of inlet time at the uppermost inlet plus time of flow in the pipes.

Rain fall data are plotted as rainfall intensity-duration-frequency curves, an example of which is shown in Fig. 2.

The curve for a given frequency (return period) is a plot of several storms of varying lengths, not a single storm plotted against time. Thus, a storm of five minutes duration is a storm lasting five minutes and no longer. The point on the same curve corresponding to six minutes duration is a six-minute storm, not an extension of the five-minute storm. A few trial computations will show that the greatest runoff almost always occurs when the entire area is contributing runoff, and the greatest instantaneous flow will occur from a storm that stops at the instant the entire area is contributing. Any longer storm would have a lower rainfall rate and hence a lower peak runoff. Therefore, to arrive at a maximum design flow, the rainfall intensity-duration-frequency curve is entered at a rainfall duration value equal to the estimated time of concentration.

5. EQUIVALENT AREAS

Determination of the equivalent drainage area of each inlet and building connection is the next step. Equivalent area is the product of actual area times the runoff coefficient, C. It is a convenient value for use in design calculations and gives a common factor for comparing various inlets. Before computing equivalent areas, the designer must have a completed site plan showing all final contours and grading elevations. Using the final grading map, the designer traces out the borders of every inlet drainage area on the site. This step will incidentally provide a good check on inlet placement, since the entire site must be included in the drainage area of some inlet. Any area not so included will indicate the need for an additional inlet. The only exception to this rule is an area on the edge of the site that drains off the site, independently of the storm sewer system, but even here a check should be made to make certain that the drainage from such areas does not reenter the site at another location.

Areas off the site that drain onto the site, and are tributary to the storm sewer system, must be included in the computations. Where detailed grading plans for these off-site areas are not available, the designer has to make conservative assumptions regarding the extent and nature of these areas.

Type of surface, whether paved, roof, or lawn, must next be shown on the grading plan. This is best accomplished by using different colored crayons to shade the different types of surfaces. Areas of the various types of surface tributary to each inlet can then be measured with a planimeter and noted in the appropriate column of a design form used for this purpose. A typical example is shown here as Form 1. Each line refers to a separate inlet or building connection. A detailed description of the form accompanies the form, which appears on the following page.

6. HYDRAULIC DESIGN

After completing Form 1, the designer fixes the exact size, slope, and inverts of all sewer pipes. There are several rules controlling this phase of the work which should be reviewed before proceeding:

1. Minimum size of all pipes, except building connections, should be 12 inches. This prevents clogging by debris which commonly enters storm sewers and could easily clog a smaller pipe.
2. Slopes should provide a minimum velocity, under design conditions, of 2 fps. This will prevent disposition within the pipe during periods of peak flow and will provide occasional high velocity flow to remove depositions accumulated during periods of lower flow.
3. Minimum cover over all pipes should be at least 2½ ft to provide structural protection for the pipe.
4. Sufficient change in pipe invert should be allowed at structures to provide for hydraulic losses occurring at those points.
5. Where changes in pipe size occur, pipes should be laid crown to crown so as to avoid surcharge of the upstream pipe.
6. Even values of slopes should be used in order to avoid unnecessary computation difficulties in the field. Slopes evenly divisible by four are helpful since grade boards should be set every 25 feet during construction.
7. A little extra excavation to provide a steeper slope is preferable, unless rock is encountered, if it will save changing to the next larger pipe size.
8. Except under extremely unusual conditions, where a steep slope continues over a long distance, no pipe size should be reduced downstream because steeper slope is available. This is to avoid blockage by objects which might become jammed in the smaller pipe.
9. An inlet or manhole should be provided at every change in direction or slope of the sewer.

STORM SEWER DESIGN FORM 1
EQUIVALENT AREAS FOR INLETS
PROJECT NO. 60-6
NAME GEN'L INDUSTRIES
Scale of Plan 1" = 50'

JOB NO. 102
SHEET NO. 1 OF 1
DATE 8-24-60
DESIGNED BY WWF
CHECKED BY TB

1	2	3a	3b	3c	4a	4b	4c	5a	5b	5c	6	7
Final No.	Temp. No.	Area, In.²			Area, Acres (in.² x .058)			Equiv. Acres			Total Equiv. Ac.	Remarks
								x .15	x .85	x .95		
		Grass	Paved	Roof	Grass	Paved	Roof	Grass	Paved	Roof		
A-42	1	2.54	7.72	—	.145	.443	—	.02	.38	—	.40	
A-41	2	6.59	2.40	—	.377	.137	—	.06	.12	—	.18	
A-5	3	12.26	—	—	.703	—	—	.12	—	—	.12	OFF-SITE AREA
A-4	4	1.32	4.20	—	.075	.241	—	.01	.21	—	.22	
A-22	5	2.15	4.18	—	.123	.239	—	.02	.20	—	.22	
A-21	6	2.00	3.66	—	.114	.210	—	.02	.18	—	.20	
A-2	7											MANHOLE
A-1	8	4.80	1.27	—	.275	.073	—	.04	.06	—	.10	
	B-1	—	—	10.0	—	—	.580	—	—	.55	.55	MAIN BLDG.

FORM 1. CALCULATIONS FOR FINDING EQUIVALENT AREAS. DATA FROM FIG. 1

The top of the form provides space for all pertinent information relating to the project. (It is unwise to skimp on information here, since it can be most useful and time-saving when referring back to the design sheets.)

Column 1—Reserved for the final number or letter designation of the inlet or building connection. It is best to leave this final numbering until the end, so that it can have some logical order. If final numbers are assigned too early, there will be confusion occasioned, when structures are added later.

Column 2—Temporary number designation, to be used pending final assignment of numbers. Temporary and final numbers appear together to avoid confusion when checking design.

Columns 3a, 3b, 3c—Measured drainage area in square inches (on plan) for each type of surface. Three columns are ordinarily enough. More may be added, if necessary. By providing this column for measurement in square inches, it is possible to keep a planimeter at a fixed setting, rather than having to adjust it each time it is used on a plan of different scale.

Columns 4a, 4b, 4c—Areas in acres, corresponding to the areas in columns 3a, 3b, and 3c, which areas are multiplied by a factor depending upon the scale of the site plan used.

Columns 5a, 5b, 5c—Equivalent acres for the types of surfaces in the corresponding portions of columns 3 and 4, obtained by multiplying the numbers in column 4 by the appropriate C coefficient, Table 1.

Column 6—Total equivalent acres for the inlet or building connection, a summation of the values in column 5.

Column 7—Remarks. Plenty of room is left here to allow for notes and explanations of the exceptions that always seem to occur.

Form 2 is used when determining pipe sizes and slopes. Each line refers to a section of sewer connecting two inlets, manholes or other points in the system. The design should start at the upper end of the system, at the point most distant *in time* from the outlet. In order to avoid oversizing the system, some thought is necessary to determine the time of concentration that will result in the entire drainage area contributing flow to the sewer system.

A physically shorter line with a longer inlet time may be actually farther away, timewise, from the outlet, than a physically longer line with a shorter inlet time. That line which is farthest away, timewise, should be designed first.

To select the correct starting point, the designer should compute the inlet times for all critical locations. From the inlet that looks most likely to be the start of the longest (timewise) run to the outlet, design proceeds downstream, picking up increments of equivalent areas at junction points and increasing the time of concentration by adding to the inlet time of the upper inlet the time of flow in the pipe.

After completing the design of the main line, the designer should go back and, in a similar fashion, design the several branches of the main line. If the proper starting point has been selected, farthest removed in time from the outlet, the accumulated time of concentration in a branich line will be found to be less than the time of concentration in the main line where the two join.

Note that pipe capacity downstream of the junction point will be less than the sum of the capacities upstream of the junction point, since the branch line has been designed for a shorter, harder rainfall, and its full capacity will not be required for the somewhat longer storm that will tax the capacity of the main line.

Misunderstanding and confusion invariably arise about this part of storm sewer design. In employing the rational method and using design Form 2, the increasing times of concentration used as the design proceeds downstream are times of concentration, or duration lengths, for a *series of different storms, not for extensions in time of the initial storm.* If the first section of pipe is designed for a time of concentration and hence storm duration, of seven minutes and the flow time is one minute, the second section sewer will be designed for an entirely different storm with a duration of eight minutes because it requires that length of time to get the entire upstream area contributing flow. The second section should not be considered as carrying a seven-minute storm from the upstream inlet and an eight-minute storm from the second inlet. Occurrence of the two storms at the same place at the same time would be a coincidence that occurs far less frequently than the selected design period. *If the computations of Form 2 are followed mechanically, this matter will take care of itself.*

Design proceeds, line by line, through the entire storm sewer system. It is a good idea to leave a line of the form blank when shifting to the design of a different portion of the system and to place independent portions of the sewer system on separate pages. This will help avoid confusion. No matter how much care is taken in the computations on these design forms, some confusion always seems to creep in during subsequent changes and modifications. Therefore, it is worth while to spend a little extra time and care in the initial computations.

7. FINAL DRAWINGS

With the completion of Form 2, the designer is ready to complete the final contract drawings. As previously discussed, it is advantageous to prepare a separate set of site plans showing all of the outside utilities. These plans can now be made to show the location of every inlet and building connection as well as other pertinent features of the various utility systems. The information prepared on Form 2 will enable the designer to prepare profiles of all the storm sewers. The plan layout finally selected and designed on Form 2 should be drawn on a print of the grading plan to aid in the preparation of ground profiles. A quick, easy way of taking the ground profiles off the site plans is to lay a strip of paper (adding machine tape serves admirably for this purpose) along the line of the sewer and tick off the locations of the contours where they cross the sewer. This information can then be easily transferred to the profile sheets. Since the use of tape strips tends to be inaccurate with regards to distances, it is wise to accurately scale off the distances between structures as computed on Form 2 and to adjust any discrepancies that appear on the paper strips.

After plotting the ground profiles, both existing and final grading should be shown and the pipe lines should be plotted on the profiles. It may develop in this plotting that an additional manhole is required to avoid either excessive cut or to provide sufficient cover. By providing this extra structure, which will allow a break in grade where needed, proper depth of the line can be maintained. These extra manholes are necessitated by sharp breaks in surface slopes and will be anticipated and avoided with experience. In addition to a plot of the existing and final grading and an accurate plot of the pipes themselves, the profile drawings should show the length, size, slope, and type of pipe for every length of sewer. See typical profiles, Fig. 3.

After a final check to ascertain that all structures are shown on the plan sheets, the final number or letter designations of the various structures can be assigned. This numbering system can follow any rule the designer feels will introduce some order to the system and give some clue of the structure's location on the site. When the final numbering system has been established, the information should be transferred to Forms

STORM SEWER DESIGN FORM 2

HYDRAULIC DESIGN

PROJECT NO. 60-6

NAME GEN'L INDUSTRIES

DESIGN DATA: STORM FREQUENCY 10 YRS.

RAINFALL CURVE MET. N.J.

TYPE OF PIPE RCP

ROUGHNESS COEFF. n=0.013

Gen'l. Loc.	Final Nos.		Temp. Nos.		Equiv. Ac.		"I"	Runoff	Len.	S %	Dia.	Cap.	Vel.	Time Conc.
	From	To	From	To	Add.	Tot.								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	A-5	A-4	3	4	.12	.12	5.1	.61	200	.40	12"	2.2	2.4	10.0
FRONT OF MAIN BLDG.	A-4	A-3	4	7A	.80	.92	4.8	4.41	150	.60	15"	5.0	4.0	11.4
	A-3	A-2	7A	7	—	.92	4.7	4.41	200	2.00	15"	8.9	7.3	12.0
	A-2	A-1	7	8	.97	1.89	4.6	8.70	150	1.00	18"	10.1	5.9	12.5
	A-1	A	8	9	.10	1.99	4.5	8.95	100	.40	21"	10.0	4.2	12.9
	A-42	A-41	1	2	.40	.40	6.6	2.64	150	.60	12"	2.7	3.4	5.0
	A-41	A-4	2	4	.18	.58	6.4	3.71	150	.40	15"	4.0	3.2	5.9
	BLDG	A-22	B-1	5	.55	.55	6.6	3.63	50	3.00	10"	3.6	6.6	5.0
	A-22	A-21	5	6	.22	.77	6.5	5.01	100	.60	15"	5.0	4.0	5.1
	A-21	A-2	6	7	.20	.97	6.4	6.20	100	1.00	15"	6.3	5.2	5.5

FORM 2. CALCULATIONS TO DETERMINE STORM SEWER PIPE

The top of the form provides the same information regarding the project as is found on Form 1. In addition, important design criteria, including storm frequency, type of pipe, and roughness coefficients, are recorded.

Column 1—A generalization of the location of the storm sewer being designed, useful for reference purposes.

Columns 2 and 3—Reserved for final number or letter designation for structures or points at either end of the section of sewer being designed on this line.

Columns 4 and 5—Temporary numbers for the same structures or points.

Column 6—The equivalent acres entering the system at the upper end of the section being designed. If a manhole is at the upper end of the line, rather than an inlet structure, the value at that point in the column is zero.

Column 7—The cumulative total of equivalent areas from the upper end of the system to the point in question.

Column 8—Rainfall intensity taken from the rainfall curve being used for the project at the time of concentration computed for the upper end of the section as shown in Column 15.

Column 9—Total runoff in this section of sewer line. Column 7 times Column 8. This value should never be lower than the preceding line. If, due to a manhole at the upper end of the section, the value drops, use the preceeding, larger figure.

Column 10—Length of the section being designed. If possible, this distance should be computed from dimensions given on the site plan such as width of roads, length of parking lots, etc. If no such dimensions are available, use careful scaling.

Column 11—Slope of the pipe for the section in question. Selected in conjunction with pipe size in column 12 to give a capacity at least equal to the flow given in Column 9, and at the same time maintain a reasonable depth of pipe. (See Reference No. 2 for pipe capacity curves and pipe roughness coefficients.)

Column 12—Pipe diameter as described above.

Column 13—Capacity of pipe of the size and slope established in Columns 11 and 12.

Column 14—Velocity of flow in the pipe selected.

Column 15—Time of concentration f the section being designed. This is the inlet time for the first inlet at the upper end of the line and a cumulative total of original inlet time plus time of flow for all other points along the line.

Column 16—Time of flow in the section being designed. Column 10 divided by the product of 60 times Column 14.

JOB NO. 102
SHEET NO. 1 OF 1
DATE 8-24-60
DESIGNED BY WWE
CHECKED BY PB

Time Flow	Sur. Elev.	$V^2/2g$ - Inc.		Incr. Dia.	Mics. Loss	Tot. Loss	Fall	Inv. Elev. U.S.	Inv. Elev. D.S.	Main Line Dia.	Main Line Inv.	Remarks
16	17	18	19	20	21	22	23	24	25	26	27	28
1.39	112.2	.09	—	—	—	—	.80	108.70	107.90	—	—	LONGEST RUN TIMENISE-
.62	112.0	.25	.16	.25	.09	.50	.90	107.40	106.50	—	—	MIN. PIPE SIZE
.47	111.5	.83	.58	—	.02	.60	4.00	105.90	101.90	—	—	SLOPE CONTROLLED BY SUR.
.42	106.5	.54	—	.25	.05	.30	1.50	101.60	100.10	—	—	
—	106.0	.27	—	.25	.05	.30	.40	99.80	99.40	—	—	DESIGN H.W. = 98.0 OK
.92	114.3	.18	—	—	—	—	.90	110.50	109.60	—	—	
—	112.7	.16	—	.25	.05	.30	.60	109.30	108.70	15"	107.40	MAIN LINE OK
.13	110.0	.68	—	—	—	—	1.50	107.00	105.50	—	—	SIZE FIXED BY BLDG. OUTLET
.42	109.2	.24	—	.42	.08	.50	.60	105.00	104.40	—	—	
—	107.9	.42	.18	—	.07	.25	1.00	104.15	103.15	18"	101.60	MAIN LINE OK

SIZES AND SLOPES. DATA FROM FIG. 1 AND 2 AND FROM FORM 1.

Column 17—Surface elevation at the upper end of the section. Noted as a reference to check the depth of sewer at that point.

Column 18—Velocity head, $V^2/2g$, for the velocity given in Column 14.

Column 19—Increase in velocity head over the previous line, if any. This must be carried as a loss in energy at the structure at the upper end of the section in question, otherwise the upstream pipe will be surcharged under design conditions. Increases in energy from this source are not utilized in the computations, since such increases are often dissipated by turbulence in the flow.

Column 20—Change in pipe size, if any. This value is also carried as a loss so as to lay the pipes at opposite sides of the structure crown to crown.

Column 21—Arbitrary miscellaneous losses from 0.05 ft to 0.10 ft, and added to the design to provide for hydraulic losses in the structures and to provide some flexibility for future minor relocations of the structures.

Column 22—Sum of all losses for the structure at the upper end of the section being designed. Sum of Columns 19, 20, and 21. This value is subtracted from the invert elevation of the pipe coming into the structure as given in Column 25 of the previous line to obtain the invert elevation of the pipe leaving the structure as shown in Column 24 on this line on the form. This subtraction thus provides sufficient drop across the structure to allow for all losses in the structure and so prevent any surcharge of the upstream pipe.

Column 23—Fall in the section being designed. Column 10 times Column 11.

Column 24—Invert elevation at the upper end of the section. Established to provide minimum cover at the first structure and a result of cumulative substraction after that. It is sometimes necessary to drop the pipe in order to pick up a low building connection or branch line. Such drops should be carried as miscellaneous losses in Column 21 and noted in Column 28.

Column 25—Invert elevatian at the lower end of the line. Column 24 less Column 23. The sum of losses in Column 22 of the succeeding line is subtracted from this value to give the elevation of Column 24 on the following line.

Column 26—Size of the main line pipe. Used as a check only where a branch line enters a previously designed line.

Column 27—Invert of main line pipe. Given as a check to be certain that branch lines are not surcharged by design flow in the main line pipes.

Column 28—Once again, sufficient room must be reserved for remarks.

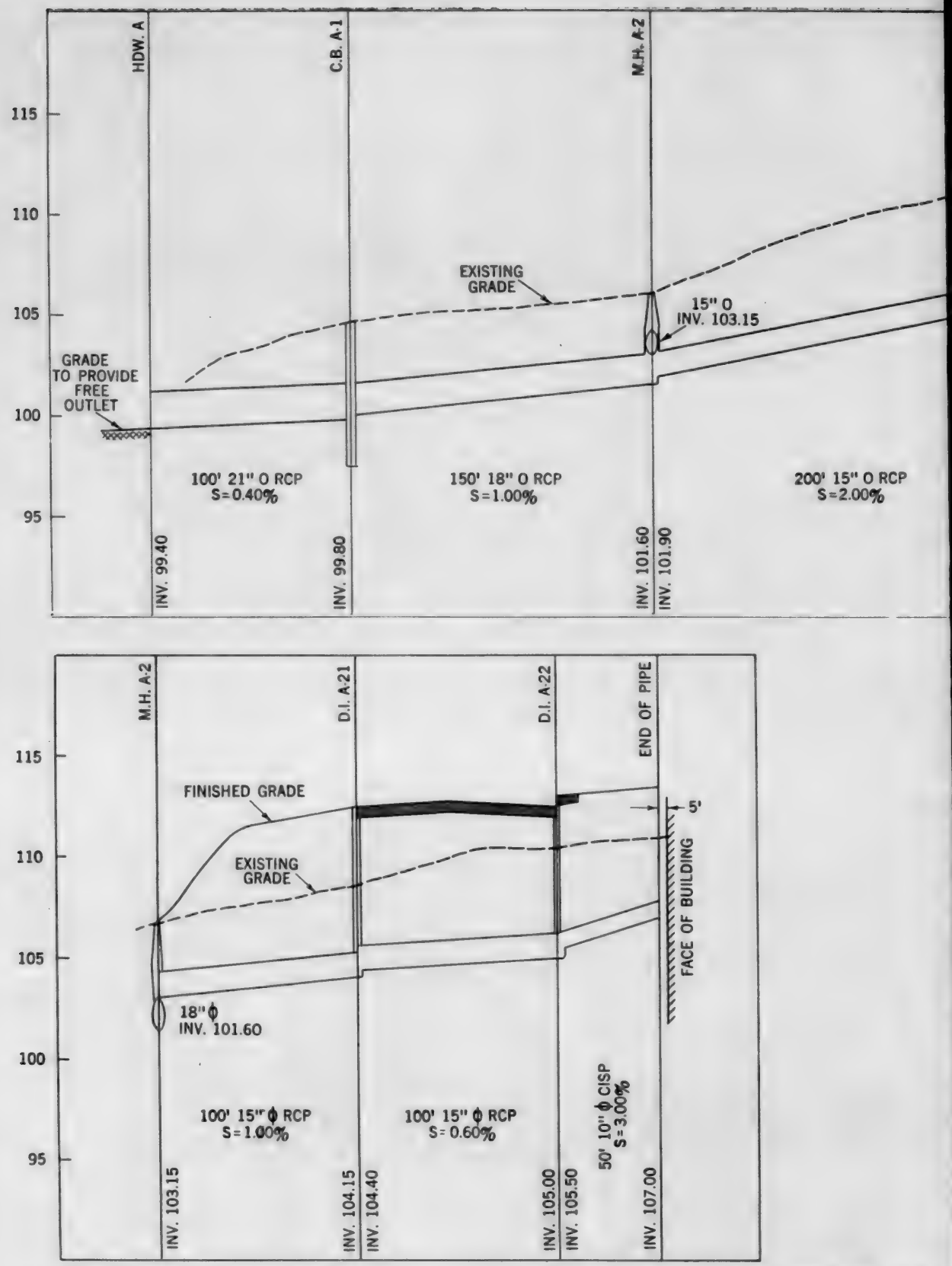
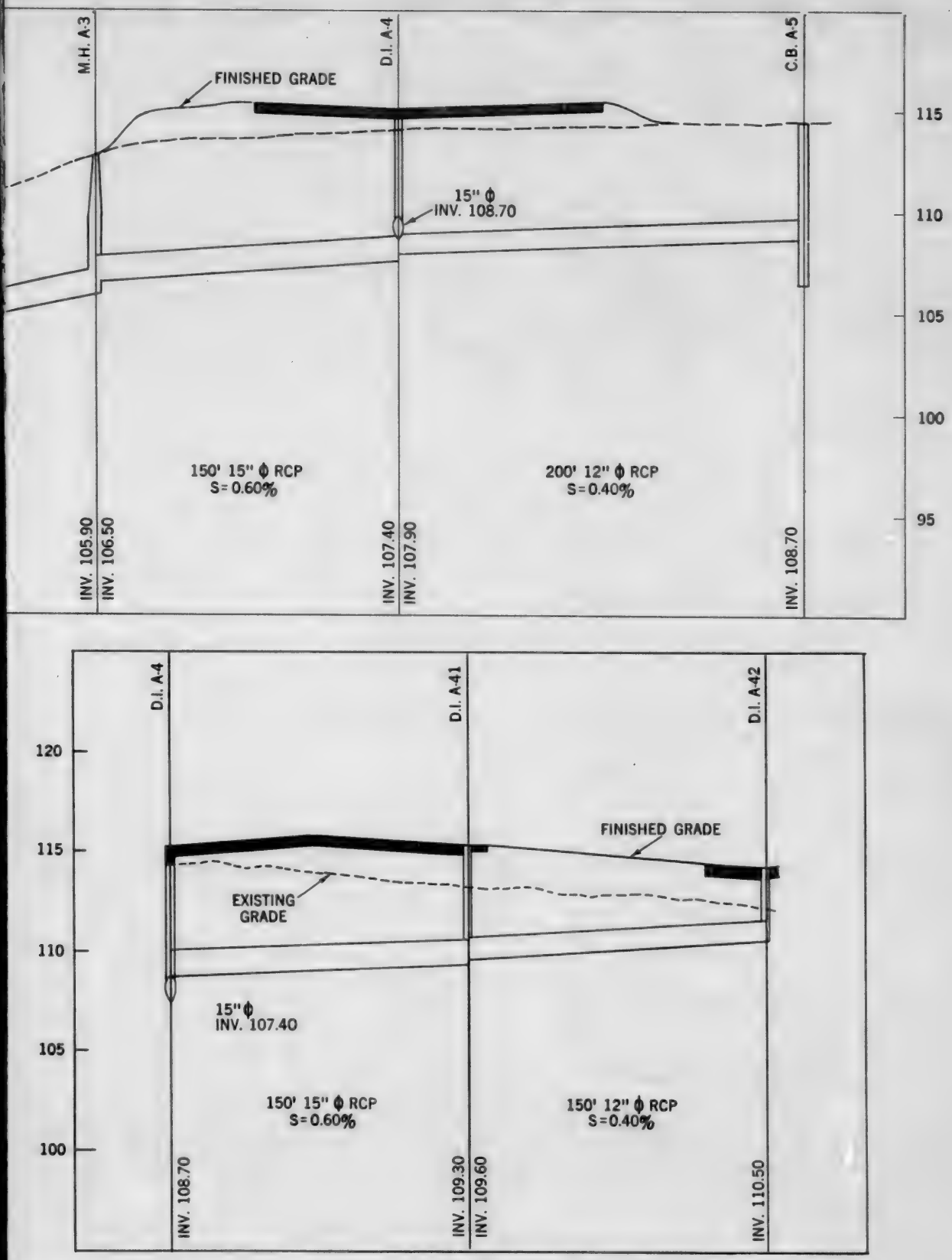


Fig. 3. Typical storm sewer profiles. Top, from Headwall A to Catch Basin A-5. Original horizontal scale was one inch equals fifty feet; original vertical



Bottom left, from Manhole A-2 to building. Bottom right, from Inlets A-4 to A-42. scale, one inch equals five feet. Data from Site Plan, Fig. 1; and Form 2.

1 and 2 immediately in order to avoid any confusion when later checking the computations.

Design of Details

In addition to plan and profile sheets, it is necessary to prepare drawings showing the details of the various structures and other incidental details such as concrete cradle, manhole steps, frames and covers, etc.

Drainage structures can be divided into three main groups: manholes, used where no surface water enters the system; drain inlets, used at any point in paved areas where surface water enters the sewers; and catch basins, which are similar to drain inlets but located in grassy or unimproved areas. All these structures are normally of brick or concrete block masonry, although precast concrete structures or concrete rings are economically available in some areas.

Structures should be reasonably watertight. It is good practice to apply a plaster coat ½ to ⅝ inch thick on the outside of all structures to minimize leakage through the joints.

All structures should be round, so that pipes can enter from any direction without the necessity of beveling the pipe or allowing it to protrude inside of the structure.

Since the primary function of the drainage structures is to provide access for maintenance and cleaning, they should be sufficiently large to allow a man to enter and work. A minimum diameter of 4 ft is recommended. With pipes larger than 24 inches in diameter, the size of the structure should be increased so that the diameter of the structure is at least 2 ft greater than the diameter of the largest pipe.

When pipe sizes become greater than 48 inches, each structure should be specially designed with consideration given to reinforced concrete boxes with an access chimney on one edge of the pipe. Manhole steps should be provided for the full height of every structure.

In order to provide for smooth flow through the structures and to minimize hydraulic losses, it is advisable to provide a flow section through each structure. This flow section should correspond to the pipe cross section with benching at the top to provide a place to stand and work. Changes in elevation and pipe sizes can be made gradually across these flow sections.

Tops of the structures can be corbelled in to meet the dimensions of the top frame, or a reinforced concrete slab provided over the top with an opening large enough to accommodate the frame. The top of the slab should be located low enough to be beneath the bottom of any road base. If necessary, a couple of rings of brick can be used to bring the frame up to grade.

Bottoms of catch basins should be provided with sumps in lieu of flow sections. These sumps should be at least 2 ft deep and will catch debris that normally accumulates in grassy or unimproved areas. They can be cleaned from time to time as required, a much easier task than cleaning the entire system to remove the same rubbish.

All frames, covers, and gratings should, if possible, be selected from the catalog of some local foundry. The number of different types of castings on the site should be held to a minimum. All castings should be "traffic weight," since even those in non-traffic areas may be subjected to heavy loads during the construction period.

Use of curb inlets, where the structure is located adjacent to a curb, is a matter that should be discussed with the site designer, since it is often the type of curbing or integral curb and gutter being used that determines the feasibility of the use of curb pieces. Where they are used, it is advisable to neglect the capacity of the curb piece, which acts as a weir, since the amount of flow entering over the weir is small when compared to the amount entering through the grating until the head on the weir becomes at least three inches or greater. This head is greater than commonly used in inlet design.

The only remaining problem is the selection of proper sized gratings for the inlets and catch basins. Most of the research that has been done in this field deals with the capacity of a series of inlets along a road, a situation more common in municipal work than on office and industrial sites. A crude method of computing inlet capacity, often employed, is based on the orifice principal. This formula for inlet capacity is,

$$Q = 2/3\, A\, C\, (2gh)^{1/2}$$

where Q is the capacity of the inlet, cfs,
$2/3$ is a factor to correct for assumed blockage of 1/3 of the inlet's net open area,
A is the net open area of the inlet,
C is an orifice coefficient, usually taken as 0.60,
g, a constant, is 32.2 ft per sec^2, and
h is the head, in feet, on the inlet, or the depth of water on top of the inlet, usually not more than two or three inches.

Selection of the proper inlet gratings for the various structures is best accomplished with the aid of Form 3.

After completion of Form 3, each type of structure can be drawn on detail sheets. The different types of inlets and differences in construction required by each should be shown in separate views. Then each type of inlet and catch basin required can be assigned a key number. A table on the detail sheet will show which combination of views should be utilized for the construction of each structure. Another large table, a schedule of structures showing the number or letter designation of each structure, the key number identifying the type of the structure, and the setting elevation for the grating top must be shown on the drawings. This setting elevation should be sufficiently below the theoretical grade at this point to insure positive flow into the structure. This depression is usually about one inch for inlets and three inches for catch basins. Pavement is warped slightly at the inlet to allow for this depression. This depression of the grating also allows for a greater head, h, on the inlet without ponding on the site.

Final items to be shown on the detail drawings are the sewer outfalls or connections to existing systems. These must be designed, both structurally and hydraulically, to meet the individual requirements of the specific location. Care must always be taken to insure against back flooding from the outlet.

STORM SEWER DESIGN FORM 3
GRATING SELECTION
PROJECT NO. 60-6
NAME GEN'L INDUSTRIES

JOB NO. 102
SHEET NO. 1 OF 1
DATE 8-24-60
DESIGNED BY WWF
CHECKED BY TB

NO.	AREA	TYPE	NO.	AREA	TYPE
1	0.80	D.I.	4	.70	CB.
2	1.20	D.I.	5	1.40	CB.
3	2.40	D.I.	6		

Inlet No. Final	Inlet No. Temp.	Type	Equiv. Area	Time Conc.	Flow	Req. Area	Tent. Grate No.	Final Grate No.	Remarks
1	2	3	4	5	6	7	8	9	
A-1	—	D.I.	.10	5.0	.66	.45	1	2	USE h = .15 Ft
A-4	—	D.I.	.22	5.0	1.45	1.08	2	2	
A-5	—	C.B.	.12	10.0	.61	.42	4	4	
A-21	—	D.I.	.20	5.0	1.42	1.05	2	2	
A-22	—	D.I.	.22	5.0	1.45	1.08	2	2	
A-41	—	D.I.	.18	5.0	1.19	.90	1	2	ELIMINATE #1
A-42	—	D.I.	.40	5.0	2.64	1.95	3	3	

KEY TO SELECTIONS:
XYZ FOUNDRY CAT.
1 #8924
2 #6930
3 #8990
4 #1981
5 #1988

FORM 3. CALCULATIONS FOR SELECTION OF INLET GRATINGS.

The top of the form has provisions for the usual project information and a list of tentative grating selections, showing catalog numbers and the net open area of the selected gratings. This open area is not usually given in the catalog, but can be readily obtained from the foundry. The type of structure requiring this particular grating, inlet, catch basin, curb piece, etc., should be noted. If the designer has had no previous experience with this particular group of gratings, the tentative selections can be made later.

Column 1—Final letter or number designation of the inlet or catch basin.

Column 2—Temporary designation. This column may not be needed if final numbers are assigned before the detail sheet is drawn.

Column 3—Type of structure.

Column 4—Equivalent drainage area for the structure, taken from Form 1.

Column 5—Time of concentration for this particular inlet or catch basin. This time of concentration is for the structure itself and is not to be confused with the time of concentration for the sewer system at this point as computed on Form 2. Since it does not influence anything but grating selection, the time of concentration can be approximated as five, ten, or fifteen minutes.

Column 6—Flow at the inlet entrance, Column 3 times the value of I from the Rainfall curve. Again, this flow is for the inlet only and does not correspond to any increase in flow at this point as computed on Form 2.

Column 7—The open area of grating required to handle the flow given in Column 5 at the maximum head, not more than three inches, assumed for the site.

Column 8—Reference number from the list of tentative gratings at the top of the sheet.

Column 9—Second selection of reference numbers from the list of tentative gratings. The number of different selections in Column 8 should be a reduction from those in Column 7. No more than two or three sizes of grating should be used on a given job. Selections appearing relatively few times in Column 7 should be eliminated in Column 8 by substituting the next larger size.

Column 10—Again, remarks.

8. TYPE OF PIPE

Of the types of pipe available for construction of storm sewers, reinforced concrete pipe is the most satisfactory for general use. Pipe should be manufactured in conformance with ASTM Specification C-76 which provides for five different strength classifications. Tables of safe cover loads and safe super-loads are available in a number of reference works. (See Reference No. 6). The designer should obtain a reliable loading table, and from it establish safe limits of cover for the various classes of pipe. Strength classification of pipe can be most conveniently shown on the profile drawings. It is best to be conservative in selecting these strength classifications in order to avoid failure due to unforeseen construction loadings. Joints for this type of pipe can normally be cement mortar type although in wet areas, rubber and concrete or rubber and steel joints may be justified.

For building connections between the building line and the first downstream structure, cast iron soil pipe is recommended. This pipe will better withstand shock loads from materials and equipment likely to be encountered in the vicinity of buildings and will also enable the designer to make use of the large variety of special fittings available in this type of pipe. While reinforced concrete pipe is available in sizes less than 12 inches in diameter, it is not standard and may be both difficult to obtain and of uncertain quality.

Corrugated metal pipe, either with or without a paved invert, is also used for storm sewer work. This type of pipe can be satisfactory, but certain precautions must be taken in its use. Any metal pipe placed in the ground must have a protective coating. Corrugated metal pipe is furnished with either bituminous or asbestos bonded coating. Great care must be exercised in the field to prevent damage to this coating. Even a small scratch can cause failure from electrolysis. Backfill over corrugated metal pipe must be of load distributing granular material and must be placed so as to provide even loads on all sides of the pipe. This is no problem in sandy soils, but may require imported backfill in other areas.

Vitrified tile and asbestos cement pipe, which are regularly used in sanitary sewers, are not satisfactory for storm sewers due to their relative brittleness and lack of strength in the larger diameters.

9. SPECIFICATIONS

Specifications for the site storm sewers naturally vary with the scope of the contract in which this work is included and the practice of the owner, architect or engineer in charge. Any project involving an appreciable amount of storm sewer work will generally have a lot of grading work included in the same contract. The specifications covering grading can, with perhaps some minor additions, be made to serve for trench excavation and backfill. These specifications, or perhaps other portions, will usually cover general items such as workmanship, masonry work, concrete, cleanup, and provisions covering acceptance of the work as a whole. *There are, however, several items that pertain to storm sewers alone and the designer must be certain that they are covered somewhere in the specifications*, preferably in a special section covering site storm sewer work rather than buried in the plumbing section. The exact wording will vary in accordance with the tone of the rest of the specifications, but the points to be covered remain essentially the same.

There should be a series of general statements covering the workmanship required specifically for storm sewers. Overall watertightness of pipe and structures should be called for. Connections to existing lines should be specified to be made without interruption of the normal operation of the existing system. Responsibility of the contractor in establishing proper line and grade from reference points furnished him must be stipulated.

The most important section of the storm sewer specifications will be that dealing with the bedding, laying, and jointing of the pipe. The importance of these operations cannot be overemphasized in the specifications. The best design in the world will be wasted if the pipe does not stay in place.

Since many construction difficulties cannot be foreseen by the designer, particularly those caused by unfavorable soil conditions, there should be a section of the specifications devoted to special construction and pipe supports to be ordered in the field. Special foundations of crushed stone or concrete should be described. Reference should be made to sheeting specifications normally covered elsewhere, and rock excavation should be covered by reference or, if necessary, by a complete description.

The type of pipe and joint should be described as completely as possible with references to standard recognized specifications, such as ASTM where applicable. Other items in the materials list, such as brick or block, iron castings, cement mortar, reinforced concrete, etc., will probably be covered in other portions of the specifications, but a reference to the appropriate section may be required.

Finally, an important section should cover the inspection and acceptance of the sewer system as a whole. The work should be watertight to the extent that there are no visible leaks, as streams or jets, in the pipes or the structures. This is not so much to ensure that water is kept out of the sewers, as to prevent failure from undermining caused by the washing into the sewer of the finer particles in the soil surrounding the sewer.

Another point to be checked in the inspection is the accuracy of line and grade of the sewers. When looking from structure to structure along the sewer, a straight, smooth line should be seen. There should be no breaks in alignment or grade and the full circle of the pipe should be visible at the other end. Sewers are laid every day to these requirements; therefore, there is certainly no need to compromise with perfection on this point.

Sloppily laid sewers lead to troubles from infiltration and structural failure and should not be allowed under any circumstances.

10. CHANGES AND REVISIONS

Design changes, particularly addition or relocation of inlets, will require review on the part of the designer. This is where complete computations on the design forms previously described will be most helpful and will return some of the extra time originally expended on them. By location of new inlets in proper relation to the entire design it is usually possible to improvise changes quickly. A new or relocated inlet will almost always intercept drainage flow originally carried to another point in the system; therefore there will be no basic change in overall system, merely a shift in details.

Pipe lines should be relocated as simply as possible to serve the new inlet and the capacity of the line, as shown on Form 2, checked against any additional flow caused by the change. If necessary a larger size or a steeper slope can be substituted until a point is reached downstream where the original conditions still hold. In making these minor changes after the completion of the design, it is not advisable to redesign the entire line involved. Simply add any extra capacity required and leave in any resulting excess capacity in other sections. Otherwise, the designer will find himself redesigning the entire system every time a minor change is made.

Another common change is a revision, usually downward, in the elevation of building outlets. These are caused by unforeseen interferences with other plumbing or with structural members within the building. Here the designer must carry the lowered sewer line at a lower elevation until the originally designed elevations are met at some point downstream. Some of the arbitrary losses introduced on Form 2 can be eliminated here to gain back the lost elevation. Care must be taken to provide equal capacity in the lowered line by holding the original slopes or by using a larger pipe.

SUMMARY

The storm sewer design procedure described here contains many steps that might be shortened or eliminated, depending on the scope of the project in question. Also, the designer will find himself by-passing some of the portions of the procedure, while other portions tend to become instinctive review rather than conscious design steps. In any curtailment of the procedure, however, the curtailment should be recognized as such, lest the designer, in gradually eliminating steps of the design procedure, inadvertently eliminate some vital portion of the work.

There are a number of general points which the designer should bear in mind throughout the preparation of the storm sewer plans and specifications:

1. Throughout the design, original design assumptions and the reasoning behind basic decisions should be kept in mind. Often, changes will be made, or new information will become available, which might affect these basic points, and the designer must not be too engrossed in details to recognize their significance.

2. The possible damage that could result from storms in excess of the design storm should be remembered. This will help pinpoint the locations at which extra safety factors of overdesign are warranted.

3. It pays to be especially cautious and conservative in studying the final outfall. It is at this location that really serious flooding trouble can develop.

4. In general, it pays to be on the generous side in the detailed design. A little extra slope or even a step-up in pipe size provide extra capacity at a nominal extra cost.

5. At the completion of the design a final check should be made of the entire system. The design high water level in the entire system should be checked to be certain that there is no inadvertent back flooding of low points on the site. Low areaways and stairwells at buildings should be particularly checked.

6. The designer should be on guard against being crowded, bit by bit, away from his original basis of design. The design of storm sewers is, admittedly, a rather nebulous affair, consisting of precise calculations based on comparatively vague assumptions of theoretical storm conditions and future development of the area. No one can argue that the future runoff coefficient might not be reduced from 0.30 to 0.27, but the designer should not allow himself to be argued, in the interest of false economy, into similar reductions in all of his design factors. The end result will inevitably be a poorly designed system. It is far better to

Mr. Fannon, a native of New England, received his B.S. in Engineering from the University of Connecticut in 1949. Following a year of employment with the Metropolitan District of Hartford, Conn. he attended the State University of Iowa at Iowa City, receiving his M.S. in Mechanics and Hydraulics in 1951. Since that time he has been employed by various governmental agencies, and has dealt primarily with hydraulics and flood control. He is presently with Elson T. Killam Associates of Millburn, N. J. as a design engineer dealing in hydraulic and sanitary projects for municipalities and private industry. He is a Member of the American Society of Civil Engineers and a registered Professional Engineer in California, Connecticut, and New Jersey.

give sufficient thought to the original selections and then stick to them throughout.

7. One economy measure that often comes up is the possibility of eliminating manholes at certain junction points in the system. The rule has been established that a manhole or other structure is required at every break in grade or change in direction. These structures are provided in order to provide access to the sewers for cleaning, inspection, and repair. Any reduction in structures will create future difficulties in these functions and will be a reduction in the quality of the design. There is, however, one reasonable point of compromise where a number of small outlets leave the building along one face. Here a manhole at either end could be considered with tee connections picking up the intervening connections. This can be considered since there will still be adequate access to the line from either end and since a substantial number of structures will be involved in the saving.

TABLE 2—SUPPORTING STRENGTH OF CONCRETE PIPE

In Kips (1000 pounds) per lineal foot of pipe. From Reference 6, below.

	Supporting Strength = Min. Three-edge Bearing load (ult.) x Bedding factor ÷ factor of safety								Supporting Strength = Min. Three edge Bearing "D" load ASTM Spec. to produce 0.01 inch crack x Internal dia. x Bedding factor ÷ factor of safety																			
ASTM Spec. No.	Standard Strength Concrete Sewer Pipe C-14-57 Safety factor=1.5				Extra Strength Concrete Sewer Pipe C-14-57 Safety factor=1.5				Reinforced Concrete Sewer Pipe C-76-57T Safety factor = 1.0 Based on 0.01" Crack																			
									CLASS I				CLASS II				CLASS III				CLASS IV				CLASS V			
Bedding Class	D	C	B	A	D	C	B	A	D	C	B	A	D	C	B	A	D	C	B	A	D	C	B	A	D	C	B	A
Bedding Factor	1.1	1.5	1.9	3.0	1.1	1.5	1.9	3.0	1.1	1.5	1.9	3.0	1.1	1.5	1.9	3.0	1.1	1.5	1.9	3.0	1.1	1.5	1.9	3.0	1.1	1.5	1.9	3.0
Internal Diameter of Pipe — Inches 6	0.8	1.1	1.4	2.2	1.5	2.0	2.5	4.0																				
8	0.9	1.3	1.6	2.6	1.5	2.0	2.5	4.0																				
10	1.0	1.4	1.7	2.8	1.5	2.0	2.5	4.0																				
12	1.1	1.5	1.9	3.0	1.6	2.2	2.8	4.5					1.1	1.5	1.9	3.0	1.5	2.0	2.6	4.0	2.2	3.0	3.8	6.0	3.3	4.5	5.7	9.0
15	1.2	1.7	2.2	3.5	2.0	2.8	3.5	5.5					1.4	1.9	2.4	3.8	1.8	2.5	3.2	5.0	2.8	3.7	4.8	7.5	4.1	5.6	7.1	11.3
18	1.4	2.0	2.5	4.0	2.4	3.3	4.2	6.6					1.6	2.2	2.8	4.5	2.2	3.0	3.8	6.1	3.3	4.5	5.7	9.0	5.0	6.8	8.6	13.5
21	1.6	2.2	2.8	4.4	2.8	3.8	4.9	7.8					1.9	2.6	3.3	5.2	2.6	3.5	4.5	7.1	3.9	5.3	6.7	10.5	5.8	7.9	10.0	15.8
24	1.7	2.4	3.0	4.8	3.3	4.4	6.6	8.8					2.2	3.0	3.8	6.0	3.0	4.0	5.1	8.1	4.4	6.0	7.6	12.0	6.6	9.0	11.4	18.0
27													2.5	3.4	4.3	6.8	3.3	4.6	5.8	9.1	4.9	6.7	8.5	13.5	7.4	10.1	12.9	20.2
30													2.7	3.7	4.7	7.5	3.7	5.1	6.4	10.1	5.5	7.5	9.5	15.0	8.2	11.2	14.2	22.5
33													3.0	4.1	5.2	8.2	4.0	5.6	7.0	11.1	6.0	8.2	10.4	16.5	9.0	12.4	15.7	25.0
36													3.3	4.5	5.7	9.0	4.4	6.1	7.7	12.2	6.6	9.0	11.4	18.0	9.9	13.5	17.1	27.0
42													3.8	5.2	6.6	10.5	5.2	7.10	8.9	14.2	7.7	10.5	13.3	21.0	11.5	15.7	20.0	31.5
48													4.4	6.0	7.5	12.0	6.0	8.1	10.2	16.2	8.8	12.0	15.2	24.0	13.2	18.0	22.8	36.0
54													4.9	6.7	8.5	13.5	6.7	9.1	11.5	18.2	9.9	13.5	17.1	27.0	14.8	20.2	25.7	40.5
60									4.4	6.0	7.6	12.0	5.5	7.5	9.5	15.0	7.4	10.1	12.8	20.2	11.0	15.0	19.0	30.0	16.5	22.5	28.5	45.0
66									4.8	6.6	8.3	13.2	6.0	8.2	10.4	16.5	8.1	11.1	14.1	22.3	12.1	16.5	21.0	33.0	18.1	24.8	31.3	49.5
72									5.3	7.2	9.1	14.4	6.6	9.0	11.4	18.0	8.9	12.1	15.4	24.3	13.2	18.0	22.8	36.0	19.8	27.0	34.2	54.0
78									5.7	7.8	9.9	15.6	7.1	9.7	12.3	19.5	9.6	13.2	16.7	26.3	14.3	19.5	24.7	39.0				
84									6.1	8.4	10.6	16.8	7.7	10.5	13.3	21.0	10.4	14.2	18.0	28.4	15.4	21.0	26.6	42.0				
90									6.6	9.0	11.4	18.0	8.2	11.2	14.2	22.5	11.1	15.2	19.2	30.4								
96									7.0	9.6	12.2	19.2	8.3	12.0	15.2	24.0	11.9	16.2	20.5	32.4								
102									7.5	10.2	12.9	20.4	9.3	12.7	16.1	25.5	12.6	17.2	21.8	34.4								
108									7.9	10.8	13.7	21.6	9.9	13.5	17.1	27.0	13.4	18.2	23.1	37.0								

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FOREIGN SUMMER DESIGN TEMPERATURES

Continued from last month. Reproduced by permission from *A Guide to Current Practice, 1959*, The Institution of Heating and Ventilating Engineers, Great Britain, and based on information from the Meteorological Office of the Air Ministry, London. To be used only when detailed investigation of local climatic conditions is not feasible.

Country and City	Ground Elevation, Ft.	Design Month	Design Temp. deg. F		Av Diurnal Range, deg. F
			Dry Bulb	Wet Bulb	
Congo, Republic of the					
Albertville	2493	Oct	90	80	20
Elisabethville	4035	Oct	96	70	33
		Dec	89	76	20
Léopoldville	1066	Feb	95	82	17
Stanleyville	1370	Feb	96	80	19
Egypt					
Alexandria	105	May	98	76	15
		Aug	91	80	13
Cairo (Helwan)	381	June	106	72	27
Dakhla Oasis	400	May	113	77	33
Ismailia	39	June	107	74	28
Luxor	256	Aug	114	80	33
Port Said	13	June	94	78	14
Quseir	31	July	99	82	14
Suez/Port Tewfik	33	June	107	77	25
Ethiopia					
Addis Ababa	8038	June	80	66	27
Asmara	7628	April	83	66	27
French Somaliland					
Djibouti	23	June	112	87	13
Gambia					
Bathurst/	90	May	100	77	22
Yundum		Sept	91	81	14
Ghana					
Accra	88	May	91	80	12
Kumasi	942	Mar	94	82	23
Takoradi	29	Mar	91	81	15
Tamale	635	Apr	102	84	21
Ivory Coast					
Abidjan	65	Mar, Apr	92	83	15
Kenya					
Kisumu	3769	Mar	92	72	17
Mombasa	52	Mar	91	79	11
Nairobi/					
Kabete	5971	Feb	83	65	24
Wajir	760	Mar	99	80	22
Liberia					
Monrovia	75	Apr	90	83	14

Country and City	Ground Elevation, Ft.	Design Month	Design Temp. deg. F		Av Diurnal Range, deg. F
			Dry Bulb	Wet Bulb	
Libya					
Benghazi	82	June	101	77	15
El Adem					
(Tobruk)	525	June	102	74	22
Idris (Castel	263	July	114	79	32
Benito)					
Jaghbub	49	June	113	76	30
(Giarabub)					
Tripoli	72	June	103	80	14
Malagasy Republic					
Diego Suarez	100	Feb	93	83	14
Tananarive	4500	Nov	88	72	23
Mauritania					
Port Etiénne	13	Sept	102	80	23
Morocco					
Casablanca	787	Aug	91	77	15
Ifrane	5364	Aug	95	69	33
Mozambique					
Beira	58	Nov	96	[illegible]	15
Lourenco					
Marques	194	Nov	100	80	16
Mossuril	49	Dec	97	83	16
Nigeria					
Calabar	40	May	93	83	15
Enugu	763	Apr	96	82	17
Ibadan	656	Mar	98	81	20
Kaduna	2113	May	97	79	19
Kano	1533	Apr	107	71	26
		June	101	79	21
Lagos	10	Mar	93	83	11
Lokoja	320	Mar	100	83	20
Maiduguri	1162	Apr	109	72	32
		July	98	81	17
Port Harcourt	50	Mar	94	81	16
Sokoto	1150	Apr	111	75	28
		July	99	81	18
Northern Rhodesia					
Broken Hill	3902	Nov	94	72	25
Livingstone	3161	Oct	101	71	27
		Dec	95	76	21
Lusaka	4191	Nov	93	73	20
Ndola	4163	Oct	93	66	30
		Dec	86	73	18

Country and City	Ground Elevation, Ft.	Design Month	Design Temp. deg. F		Av Diurnal Range, deg. F
			Dry Bulb	Wet Bulb	
Nyasaland					
Karonga	1596	Dec	94	78	21
Zomba	3141	Nov	93	76	19
Portugese Guinea					
Bolama	62	Apr	99	79	18
Senegal					
Dakar	131	Mar	98	74	16
		Sept	94	83	13
Sierra Leone					
Freetown (Falconbridge)	37	Apr	92	81	10
Socotra					
Socotra	141	May	100	84	14
Somali Republic					
Bender Cassim	23	June, Aug	108	92	18
Berbera	45	June	112	89	21
Hargeisa	4377	June	92	69	24
Mogadiscio	39	Apr	92	84	12
Soudan (West Africa)					
Gao	902	June	112	78	25
		Aug	101	82	17
Kayes	98	May	115	84	29
		June	110	87	23
Southern Rhodesia					
Bulawayo	4405	Oct	95	67	26
		Dec	91	72	21
Salisbury	4831	Nov	90	70	21
South West Africa					
Gobabis	4741	Jan	96	70	27
Keetmanshoop	3295	Feb	102	70	31
Tsumeb	4301	Feb	94	73	21
		Oct	98	68	26
Walvis Bay	24	May	96	74	22
Windhoek	5669	Jan	92	67	22
Spanish Sahara					
Sidi Ifni	148	Sept	92	77	11
Villa Cisneros	35	Oct	95	75	15
Sudan					
El Fasher	2395	May	109	70	34
		Aug	103	77	23
El Obeid	1887	May	108	75	30
		July	100	79	21
Juba	1509	Mar	106	79	27
Khartoum	1279	June	113	76	27
		July	109	80	24
Port Sudan	18	July	114	88	23
Wadi Halfa	410	May	115	72	34
Tanganyika					
Dar-es-Salaam	47	Mar	91	83	13
Lindi	26	Apr	92	82	15
Tabora	4151	Nov	93	72	21
Tangier					
Tangier	239	Aug	91	75	17
Tunisia					
Gabes	7	Aug	103	83	19
Tunis	217	Aug	107	80	22
Uganda					
Entebbe	3878	Mar	85	74	14
Kampala	4304	Feb	89	73	17
Masindi	3760	Mar	95	76	23
Union of South Africa					
Capetown	56	Mar	93	72	19
Durban	16	Feb	87	76	12
East London	410	Sept	92	71	16
Johannesburg (Germiston)	5463	Jan	87	69	20
Kimberley	3927	Jan	99	71	27
Oudtshoorn	1099	Jan	106	76	30
Port Elizabeth	190	Mar	93	74	16
Pretoria	4491	Jan	90	71	21
Upper Volta					
Ouagadougou	991	May	108	83	23
Zanzibar					
Chukwani	61	Feb	97	83	15

Asia

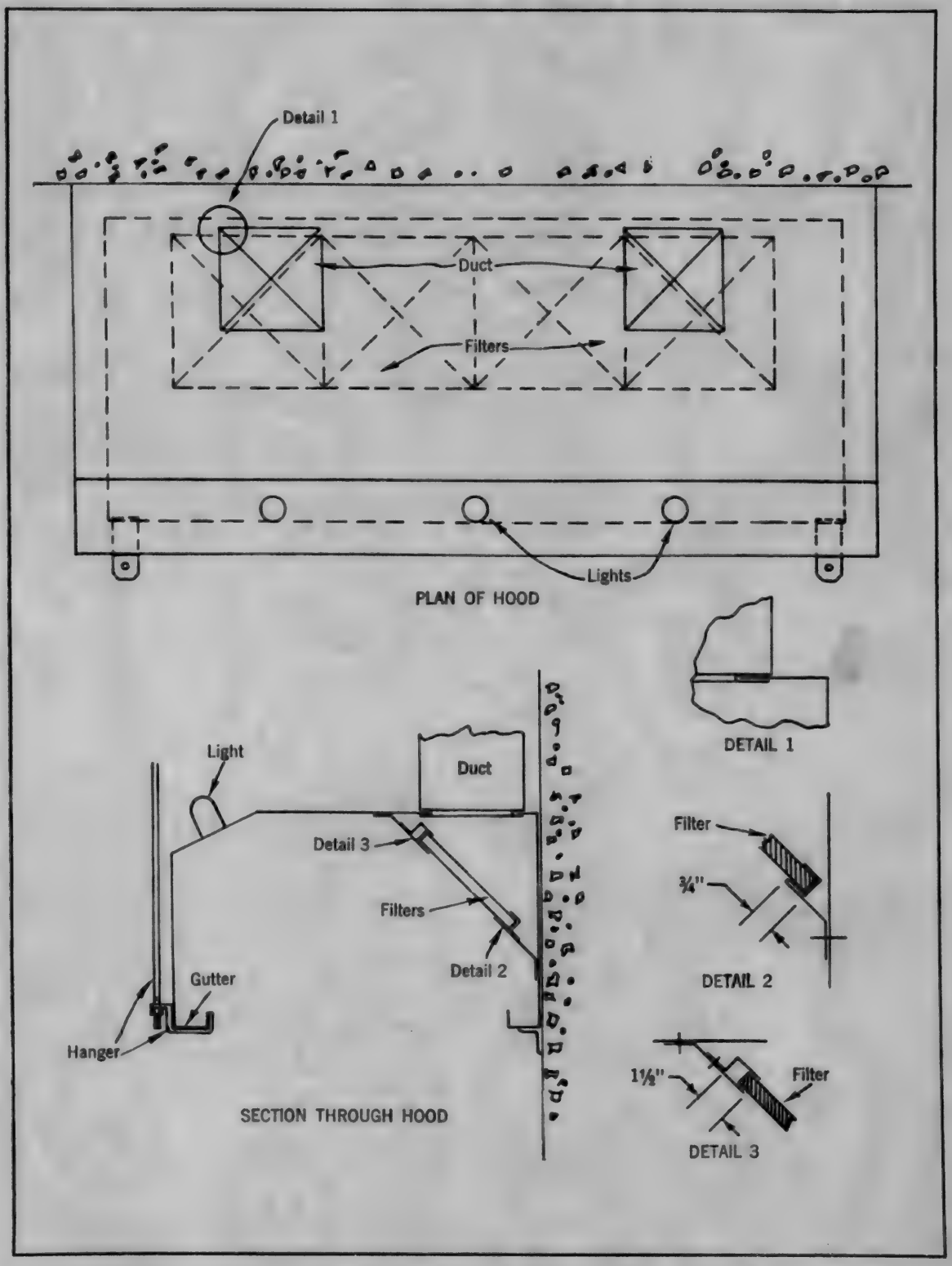
Afghanistan					
Kabul	5955	July	99	*	31
Arabia					
Aden (Khormaksar)	22	June	102	84	14
Bahrain	18	July	108	94	14
Jidda	20	June	108	86	22
Kuwait City	16	Aug	113	88	18
Riyādh	1938	June	112	*	30

* No suitable data available on which to base design wet bulb.

(The table is concluded next month)

HOOD WITH GREASE FILTERS

Open Type Hood Placed at an Inner Wall

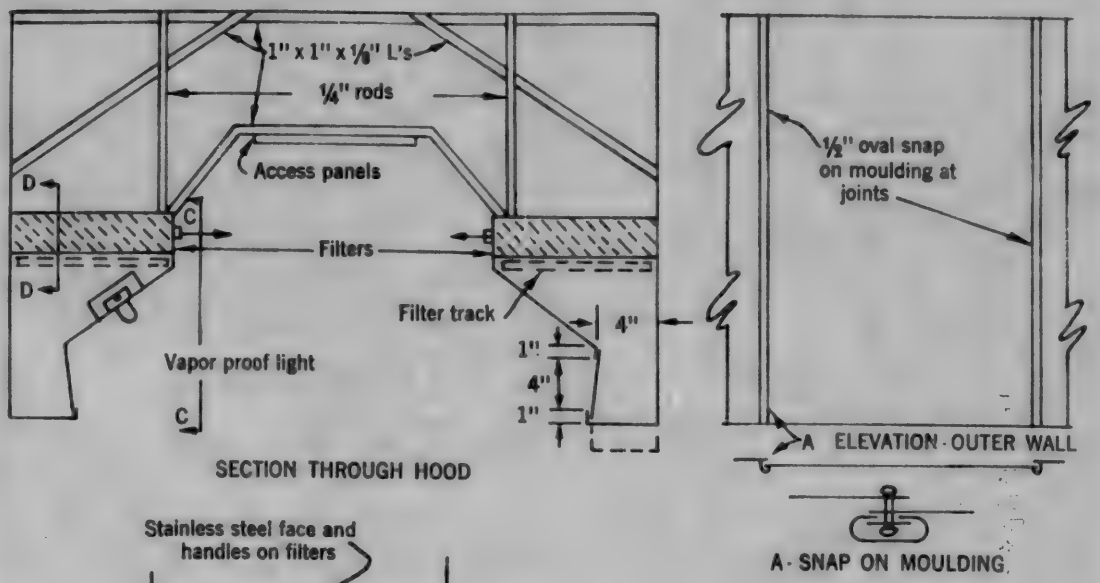


DETAIL SHEET—AIR CONDITIONING, HEATING AND VENTILATING

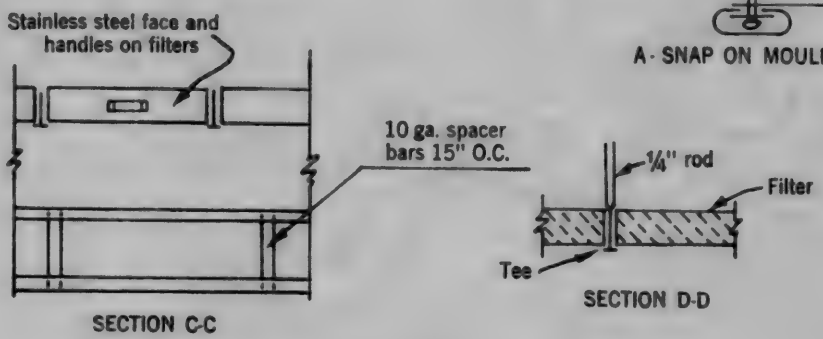
January, 1961

HOOD WITH GREASE FILTERS

Details of Double Wall Type Hood

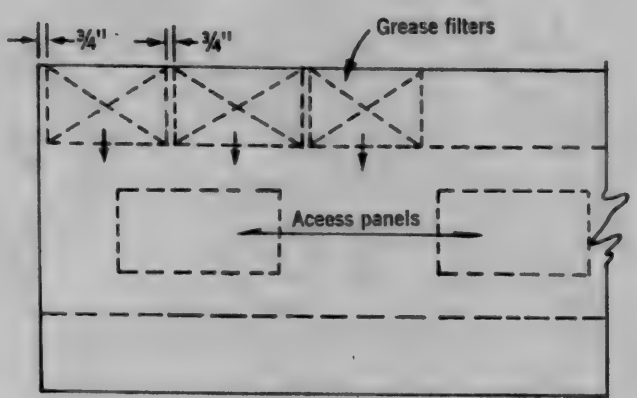


SECTION THROUGH HOOD



SECTION C-C

SECTION D-D



PLAN - SECTION OF HOOD

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Design of an air conditioner for a given load and for given inlet and outlet air conditions is rather straight-forward compared with the problem of evaluating the performance of a given unit at various inlet air conditions. However, an estimate of the performance of a unit at off-design conditions is frequently required.

This article describes a method which has been proved very effective in predicting the performance of air conditioners by experimental studies conducted at the Research Laboratory of Mitsubishi Heavy-Industries, Reorganized, Ltd., Nagoya, Japan. It should prove of particular value to manufacturers' engineers who are called upon to furnish data on unit performance at many different conditions. Consultants who often must have these data, may glean from these experiments the type of performance data they might reasonably expect from the manufacturer.

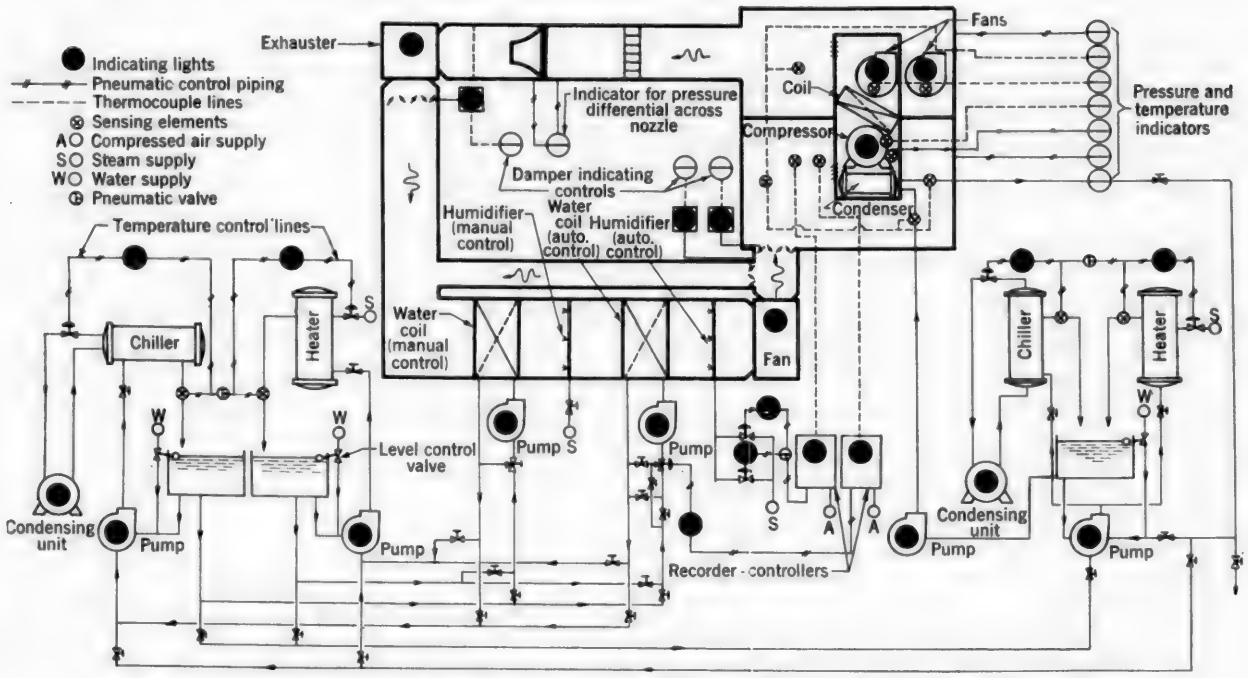


Fig. 1. Schematic diagram of authors' experimental apparatus as seen on apparatus control panel.

Performance of Air Conditioners At Off-Design Conditions Part 1

HIDEO SUENAGA and TAKASHI OTAKI
Mitsubishi Heavy-Industries, Reorganized, Ltd.
Nagoya, Japan

SOME TIME AGO Mr. T. Kusuda[1] introduced a graphical method to evaluate wet surface temperature of air conditioning coils on a psychrometric chart. His method enables one to calculate the performance of an evaporator coil for a given refrigerant temperature, entering air volume, flow rate, and entering air wet-bulb temperature. The authors' test results showed remarkable agreement between calculated surface temperature and apparatus dew point obtained from experimental air conditions measured before and after the coil.

Mr. Kusuda's graphical method was extended to include the condensing unit, so that the entire characteristic performance of an air conditioner can now be presented on a single psychrometric chart. Presented herein are analyses of the important factors in air conditioner performance.

Figures 1 and 2 describe the test apparatus and the conditions it will

[1] Superscripts refer to references at the end of Part 2 of this article.

NOMENCLATURE

A_o = Coil heat transfer surface, square meters.

BF = Coil by pass factor = 1 — CF

CF = Coil contact factor

C_p = Moist air specific = 0.243 kcal per (kg) (deg C).

d = Coil tube ID, meters.

exp = The exponential function. For instance, exp $x = e^x$.

G = Air weight flow rate, kg per hr.

G_r = Refrigerant weight flow rate, kg per hr.

h_1 = Refrigerant side heat transfer coefficient, kcal per (sq meter) (hr) (deg C).

h_2 = condensed water film heat transfer coefficient, kcal per (sq m) (hr) (deg C).

h_3 = Air side heat transfer coefficient, kcal per (sq m) (hr) (deg C).

h^e_a = Entering air enthalpy, kcal per kg.

h_s = Enthalpy corresponding to t_s, kcal per kg.

Δh_a = Air side enthalpy drop, kcal per kg.

Δh_r = Air side enthalpy drop, corresponding to condensing capacity at t_r, kcal per kg.

K = Coil characteristic, (deg C) (kg) per kcal.

N_{Nu} = Nusselt number, dimensionless, defined as $h_3 d_e / K_1$, where h_3 is as defined above, K_1 = air thermal conductivity, Btu per (sq ft) (hr) (deg F); d_e = 4rh, in meters; rh = hydraulic radius, meters = S/p; S = minimum opening area divided by two fins and two tubes, square meters; and P = wetted perimeter, meters.

q = Heat flux per coil inside surface, kcal per (sq m) (hr).

Q = Total cooling capacity, kcal per hr.

R = Coil heat resistance, (sq m) (hr) (deg C) per kcal

N_{Re} = Reynolds number, dimensionless = $V_m d_e / v$, where V_m = maximum air velocity through the minimum face area of the coil, meters per second, d_e is equivalent diameter, meters, and v = air kinematic viscosity, sq m per sec.

r_m = Fin metal resistance, (sq m) (hr) (deg C) per kcal.

S_F = Finned surface, square meters.

S_p = Primary (non-finned) surface, square meters.

t^e_a = Entering air dry bulb, deg C.

t^l_a = Leaving air dry bulb, deg C.

$t^{e'}_a$ = Entering air wet bulb, deg C.

$t^{l'}_a$ = Leaving air wet bulb, deg C.

t_s = Coil average surface temperature, or ADP (apparatus dew point), deg C.

t_r = Refrigerant temperature, deg C.

τ = Coil surface ratio, outside to inside.

ϕ = Coil fin efficiency.

CONVERSION FACTORS

1 square meter = 10.76 sq ft.
1 kcal per (kg) (deg C) = 1 Btu per (lb) (deg F).
1 meter = 3.281 ft.
1 kg per hr = 2.205 lb per hr.
1 kcal per (sq m) (hr) (deg C) = 0.204 Btu per (sq ft) (hr) (deg F).
1 kcal per kg = 1.8 Btu per lb.
1 (deg C) (kg) per kcal = 1 (deg F) (lb) per Btu.
1 kcal per (sq m) (hr) = 0.3687 Btu per (sq ft) (hr).
1 kcal per hr = 3.968 Btu per hr.
1 (sq m) (hr) (deg C) per kcal = 4.883 (sq ft) (hr) (deg F) per Btu.
1 meter per second = 3.281 ft per sec.
1 sq m per sec = 10.76 sq ft per sec.
Degrees Centigrade = (5/9) (deg F — 32).

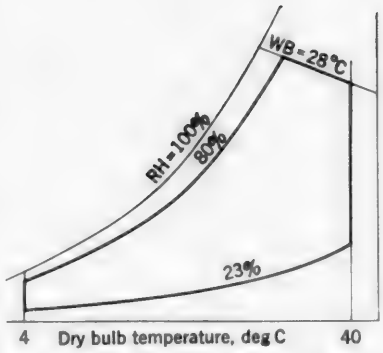


Fig. 2. Range of conditions of supply air which apparatus will maintain.

maintain. After the test room and air conditioner had attained a steady state, the following quantities were measured: air conditioner inlet and outlet dry and wet bulbs, condensing, suction, and coil inlet and outlet refrigerant pressures, coil return bend temperatures, coil surface condensing rate, condenser water rate, water temperature to and from condenser, fan motor and compressor motor kw input.

Using the measured quantities, the following were calculated: air conditioner cooling capacity, sensible heat factor, dew point, coil contact factors, and apparatus dew points.

Psychrometric data used for the computation are prepared by an IBM computer using accurate thermodynamic equations for moist air.

Conditioner Coil Analysis

According to Kusuda,[1] performance of a direct expansion air coil can be represented by the following equation:

$$Q = G\,(h_a^e - h_s)\,(CF) = \frac{t_s - t_r}{R} A_o \qquad (1)$$

where

$$CF = 1 - \exp\left(-\frac{h_3 A_o}{G C_p}\right) \qquad (2)$$

$$R = \frac{\tau}{h_1} + r_m + \frac{1}{h_2} \qquad (3)$$

$$r_m = \frac{1}{h_3}\left[\frac{1-\phi}{\phi + \dfrac{S_p}{S_F}}\right] \qquad (4)$$

These relations are valid only when

(1) Coil surface temperature is assumed constant, equal to the apparatus dew point of the all fresh air system. Surface temperature (or ADP) is determined by the intersection of the extended lines connecting coil inlet and outlet air conditions and the saturation curve on a psychrometric chart. (Actually, the condition of the air upon entering each row of a deep coil does not follow a straight line connecting the coil inlet and outlet conditions on a psychrometric chart. Rather it follows a curve. Nevertheless, the coil surface temperature (or ADP) is a very powerful tool in estimating performance.)

(2) Refrigerant temperature in the coil is assumed constant. This assumption is not valid if the refrigerant pressure drop or superheat in the coil are great.

Kusuda introduced a quality, K,

$$K = \frac{G\,(CF)\,R}{A_o}$$

and named it the "coil characteristic." He also introduced a line called *STDL* (Surface Temperature Determination Line) on the psychrometric chart. By geometrically combining *STDL* and a slope line representing the coil characteristic, K, on a psychrometric chart, as shown in Fig. 3, he produced a method that enables one to determine ADP, knowing the entering air wet bulb, volume flow rate, refrigerant temperature, and the geometrical configuration of the coil. In order to determine the outlet air condition from the coil, one also must know the air inlet dry bulb temperature.

To evaluate air conditioner performance, the method described is not sufficient, because refrigerant temperature in the coil is not predetermined. As the load on it varies, an air conditioner balances its evaporator temperature against its condenser's saturation suction temperature by modulating its thermostatic expansion valve.

However, since the surface temperature determination chart introduced by Kusuda has a scale that represents refrigerant temperature, condensing unit capacity curves can

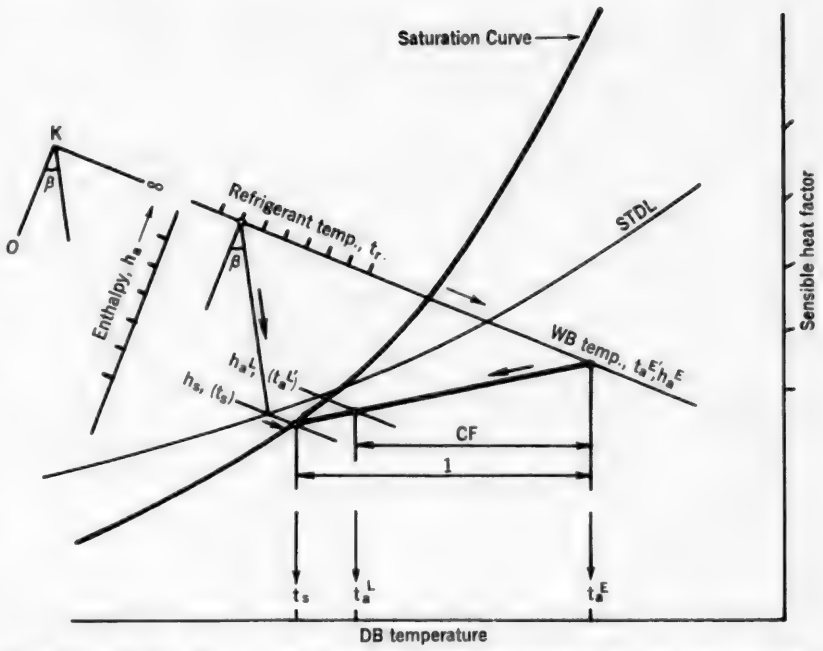


Fig. 3. Coil ADP determined graphically on psychrometric chart from the coil characteristic, K and the surface temperature determination line, STDL.

be plotted on the same coordinate provided that:

(1) condensing capacity, Q, is converted into an equivalent air enthalpy drop at a given refrigerant temperature by $\Delta h_r = Q/G$, and

(2) pressure drop through the coil and suction line must be adjusted to find a corresponding Q at t_r.

After that, one can plot Δh_r *vs.* t_r on the $h - t_r$ coordinates proposed by Kusuda on a psychrometric chart for various condensing temperatures, such as is done in Fig. 4. These curves may be called *condensing unit characteristic curves.*

In Fig. 4, *K, STDL,* entering wet bulb,, dry bulb and *CF* would provide Δh_a, enthalpy drop of the air across the coil, according to the Kusuda method. Now, if the constant enthalpy line is extended at the coil outlet air condition, the intersection of the extended line and

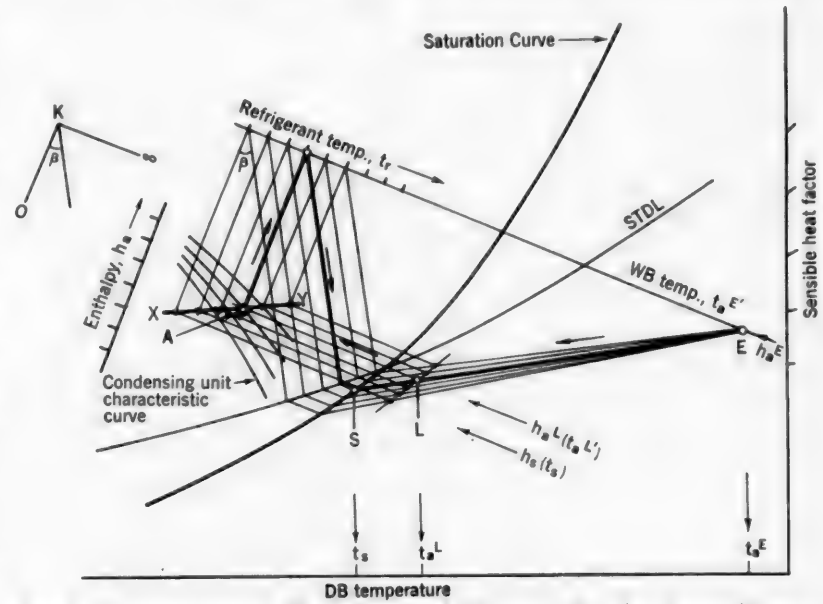


Fig. 4. The procedure of Fig. 3 is extended to describe the air conditioning unit as a whole. Result is family of curves.

Hideo Suenga, 36, and Takashi Otaki, 30, are both employees of Mitsubishi's Engineering Department No. 2. The company is one of Japan's leading industrial producers of aircraft, ships, rolling stock, motors, textile machinery, and refrigeration machinery, from ice-cream freezers to high-speed, multi-cylinder compressors.

Mr. Suenga, in the Refrigeration Machine Design Section of his department, is engaged in designing packaged and window units, bus and car coolers, among others. Mr. Otaki, in the Products Research Section, tests and researches them. Both men have been with the company for more than six years.

the constant t_r line would determine an operating point. If the same process is repeated for several values of t_r, a locus of the operating points is determined, curve XY in Fig. 4. The intersection, A of the curve XY and a condensing unit characteristic curve corresponding to a condensing temperature, would then yield the balanced refrigerant temperature, t_r, of the air conditioner. Consequently, the coil performance and leaving air condition at the balanced refrigerant temperature, t_r, can be found.

After determining the leaving air condition of the coil, the sensible heat corresponding to fan motor heat, if it is of the draw-through type, must be subtracted. Fan motor heat would increase the dry-bulb also. However, inclusion of fan heat does not alter performance considerably.

Coil surface temperature determined by this method for various entering wet bulb temperatures fall on a straight line, as shown in Fig. 5. In Fig. 5 is also plotted the coil surface temperatures obtained by the authors' experiment. It is very interesting to note how close they agree. This justifies use of the Kusuda method to calculate coil surface temperature (or ADP).

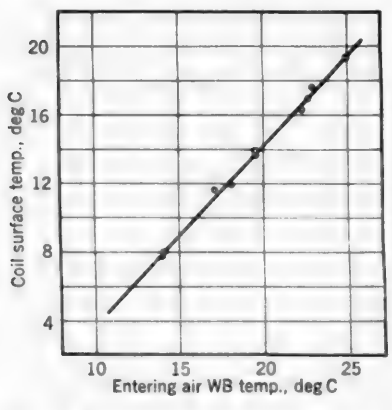


Fig. 5. Experimental points are very close to computed straightline coil surface vs. entering-air function.

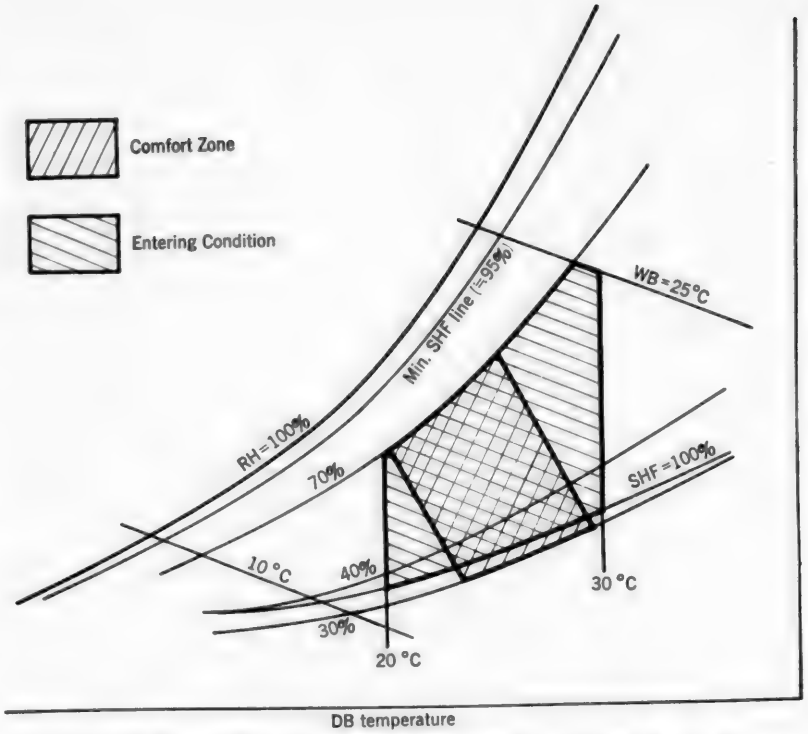


Fig. 6. Zones of comfort and entering-air conditions for coil.

Factors Influencing Performance

For a cooling and dehumidifying coil whose surface temperatures and entering wet bulb temperatures are related as in Fig. 5, it is possible to draw a critical entering air condition line on the psychrometric chart beyond which sensible heat factor becomes unity. It is also possible to draw a line representing entering air conditions beyond which coil performance is unattainable. The minimum possible sensible heat factor will be determined by a tangent to the saturation line drawn from the entering air conditions. In Fig. 6 are drawn lines of maximum sensible heat factor; minimum sensible heat factor; the zone enclosed by these two lines, which represents entering air conditions to the air conditioner, within which dehumidification is possible; and the general comfort zone.[2]

Having established a dehumidification zone and a comfort zone on the psychrometric chart, a zone of suitable air conditioner inlet air conditions can be established. In Fig. 6, the zone enclosed by the 20 deg C (68 deg F) dry bulb line, the 70% relative humidity curve, the 25 deg C (77 deg F) wet bulb line, the 30 deg C (86 deg F) dry bulb line, and the 100% sensible heat factor curve is tentatively selected as the zone suitable as air conditioner inlet air conditions. Fig. 7 illustrates this particular zone on a chart representing sensible heat factor *vs.* inlet air wet bulb temperature. This chart is based on the coil surface temperature *vs.* entering wet bulb relation shown in Fig. 5. Sensible heat factors obtainable by an air conditioner should be in this zone.

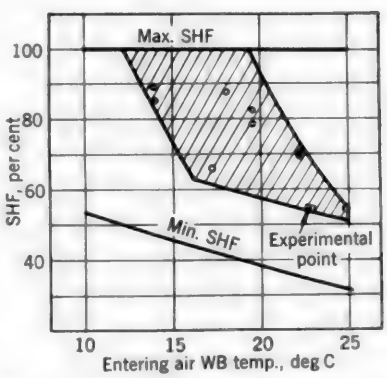


Fig. 7. Entering-condition zone of Fig. 6 plotted on SHF-entering-air ordinates.

(Concluded next month.)

Design of Water Systems for Air Conditioning

MAURICE J. WILSON

Sales Manager, Commercial Equipment, Unitary Equipment Division,
Carrier Corp., Syracuse, N. Y.

Information is presented on some of the design problems encountered in water systems. Included are some of the comparative advantages of constant and variable flow, optimum flow rates, dirt legs, and general pointers with respect to such systems.

SOME air conditioning systems utilize water as one of the fluids for (1) extracting or (2) adding heat. Water is also used in the central air treating apparatus of many systems for the same purpose. Generally speaking, these water systems are the closed or recirculating type. Here are some general statements with respect to such systems.

1. Constant flow systems are inherently stable and maintain the design pressure balance during operation.
2. Variable flow systems with wide variations in system friction and different pressure heads developed by the pump may cause excessive noise, velocities and pressure differences in certain segments of the circuit. Such systems should receive due consideration during the design phase to minimize these difficulties.
3. With respect to overall cost:
   a. The longer the circuit, the lower the flow rate and consequently higher rise.
   b. The longer the operating period, the lower the flow rate to reduce operating cost.
   c. The longer the circuit, the lower the velocity.
   d. The longer the operating period, the lower the velocity.
   e. The higher the pump rpm, the greater the possibility of noise and vibration difficulties.
4. Another point which may be of interest and can be used for quick checking of velocity and friction is the following approximate relationship. A 5-inch diameter pipe will handle 500 gpm at 8 fps and 8 ft per 100 ft pressure drop. Keeping in mind these relationships, one can determine readily the velocity and friction for a particular design. For example, assume 400 gpm in a 5-inch pipe. The velocity would be $4/5 \times 8 = 6.4$ fps.

As mentioned previously, constant flow systems are stable. The design of such systems, however, should consider such items as operation pressure level throughout the circuit, location and need for dirt legs, vents and service valves.

Constant Flow System Pressure

Let us examine now the operating pressure level in

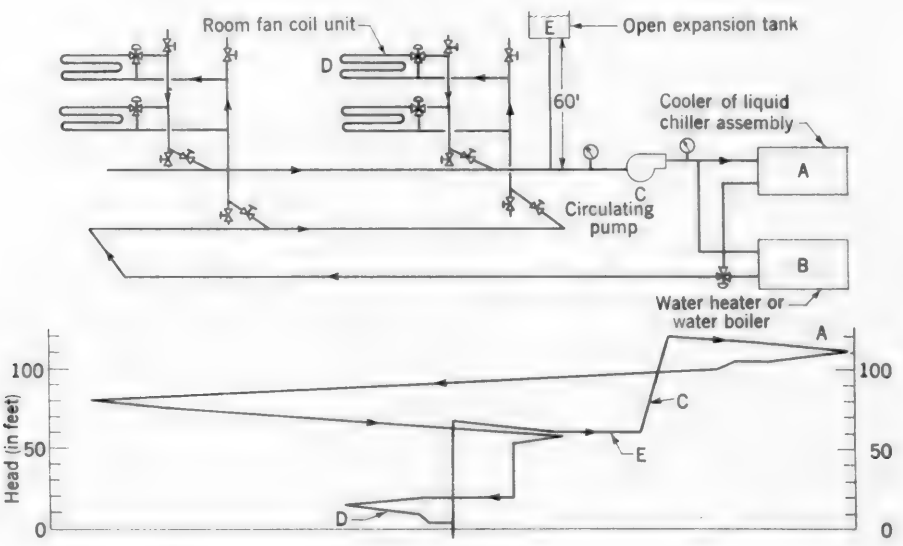


Fig. 1. (Top) Schematic of constant flow system; (below) graph to show pressure in various parts of the water system.

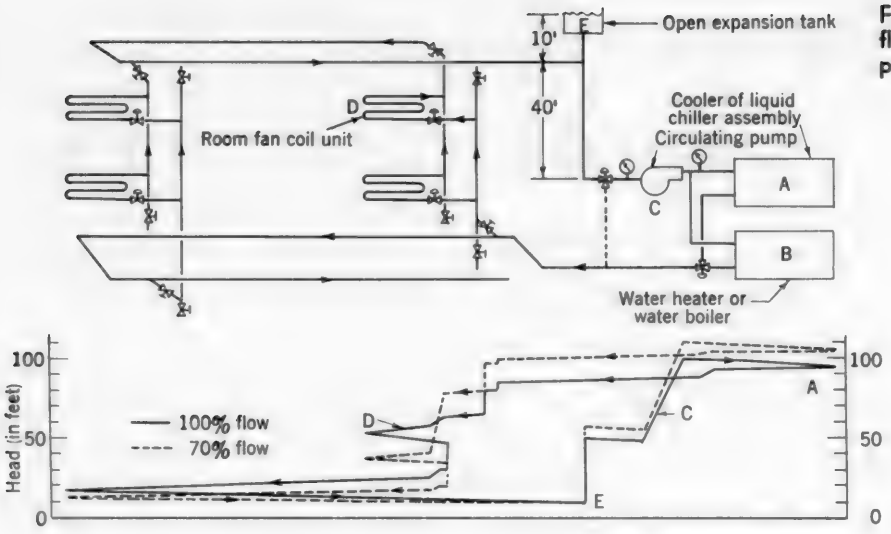


Fig. 2. (Top) Schematic of variable flow system; (below) graph to show pressure in various parts of the water system.

a constant flow water system that may be considered of conventional design.

Figure 1 shows a circulating system with reversed headers and upfeed direct risers. It could serve a building of several floors. Design pressure level and flow can be maintained because system friction is substantially constant throughout the operating period. The graph in the lower half shows the pressure levels which prevail in any portion of the circuit. A balance tank *E* has a connection at the pump suction. This results in the maximum elevation of system pressure level for any specific tank location. The tank connection could be at the top of the return riser nearest the pump; however, system pressure level would be lowered by the friction drop in the intervening piping as indicated. Such a situation may cause trouble unless tank location gives the required static head to keep a positive pressure in all the circuit.

Parts of Constant Flow System

A direct riser arrangement is satisfactory for such a constant flow system and can also be used on a variable flow system. The variation in pressure difference across each pair of run-outs should not be in excess of approximately 8 ft. Dirt legs should be used, especially on systems with intermittent operations, such as office buildings, to avoid clogged run-outs. Sediment in the water will settle during the shutdown period but may be blown-out through suitably equipped legs. Air vents on both supply and return are needed, especially on systems which reverse from hot to cold water. The air released with increased temperature may cause noise problems. Unit capacity control is obtained with 3-way valves located to serve as mixing instead of diverting valves, thus eliminating the possibility of slapping or quick closing when approaching shut-off. This control scheme does not assure constant flow because the intermediate position provides two flow circuits thus reducing the friction to 25% of design in this portion of the circuit. The change in flow rate, however, is not of significant magnitude. The operating point for the pump remains substantially constant as shown at the lower right. Also note that static head at the air vent on return riser serving unit *D* is negative. This may result if the balance tank elevation is not great enough to offset friction between the two points.

Service valves on each set of risers are needed if repairs or routine servicing is to be performed on certain segments of the system without complete drainage. If the headers were at the top such work could be performed by draining only the headers. Then each riser group would be isolated without need for the service valves.

Operating Costs

Referring now to the optimum velocities and frictions, keep in mind that it costs approximately $80 per year to circulate 100 gpm at 50-ft head in an office building with a 2800-hour operating period. The cost for a motel or hospital, with an 8000-hour operating period, however, is approximately $240 per year. These figures are based on an electric cost (energy plus demand) of two cents per kwh. Assume the installed cost for the circulating system including valves, fittings and insulation will be approximately $2 per foot per inch-diameter. A circulating system of 200 lineal feet for 1000 gpm and sized for conventional velocities will be approximately $1,000. The fixed charges, therefore, would be approximately $95 per year. If the pipe size were increased one diameter, the fixed charges would be increased approximately $20.

The decrease in pumping cost for the hotel or hospital installation would be approximately $100 to $120. Also, if pipe size were maintained, but the flow rate reduced 20% with consequent higher rise, the pumping cost would be reduced by approximately $100 because of the reduced friction as well as the lower flow rate. The same evaluation could be made for an office building installation but due to the shorter operating period, the savings will not be as great.

In general, the economic optimum flow rates, and velocities for an installation such as a hotel would be approximately 2 gpm per ton (12 deg rise) and 4 fps flow rate. For office building application, the flow and

(Concluded on page 130)

You Can't Buy Conditioning by the Ton

How to specify an air conditioner to maintain proper room humidity; How to design for high humidity requirement in hospital operating rooms.

I SAW an installation recently that is likely to be very costly to its owner. Although the designer had specified sufficient tonnage, the air conditioning system was incapable of removing the space sensible heat. The following is similar to what I saw.

A room contains a lot of heat-producing calculating equipment. A large glass area with southern exposure, even with venetian blinds, admits a large solar load. The combination of the two results in a lot of sensible heat to be removed.

Inside, a condition of 75 deg F and 50% relative humidity is desired. Relative humidity is not permitted to go below 47%. Design outside conditions: 95 deg dry bulb, 75 deg wet bulb. With a sensible load of 500,000 Btu per hr, a latent load of 15,000 Btu per hr, and a sensible plus latent load of 141,000 Btu per hr from 3,000 cfm outside air, the total load is 656,000 Btuh.

The Wrong Unit Specified

The air conditioning unit was specified to cool 19,000 cfm from 75 deg dry bulb, 62.5 deg wet bulb down to 51 deg dry bulb and 50.2 deg wet bulb. This indicated a cooling capacity of

$$19{,}000 \text{ cfm} \times 60 \left(\frac{(28.2 - 20.5) \text{ Btu per lb}}{13.4 \text{ cu ft per lb}} \right) =$$

655,000 Btu per hr, where (28.2 – 20.5) is the difference in enthalpies of the entering and leaving air streams, and 13.4 is the specific volume of standard air.

Thus, the unit has the right capacity. Why doesn't it work? First of all, the wrong entering condition is specified. The 19,000 cfm entering the unit must contain 3,000 cfm of outside air at design outside conditions and 16,000 cfm of room air at design inside conditions, which would produce a mixture at 78.2 deg dry bulb and 64.5 deg wet bulb. (Dry bulb is 16,000 × 75 plus 3,000 × 95, all divided by 19,000. Wet bulb is read at the 78.2 deg dry bulb point on a straight line on the psychrometric chart, between 95 deg dry bulb with 75 deg wet bulb and 75 deg dry bulb with 50% rh.)

Now let's look at the room conditions which will be the result of air entering at 51 deg dry bulb and 50.2 deg wet bulb at the rate of 19,000 cfm. Since space sensible heat gain is 500,000 Btu per hr, the resulting room temperature will be

$$51 + \frac{500{,}000}{19{,}000 \times 1.08} = 75.5 \text{ deg F},$$

which is not bad.

At 51 deg dry bulb and 50.2 deg wet bulb, the specified leaving air conditions, the moisture content is 53 grains per pound. Since space latent heat gain is 15,000 Btu per hr, the resulting room moisture content will be

$$53 + \frac{15{,}000}{19{,}000 \times 0.67} = 54.2 \text{ gr per lb.}$$

At 75.5 deg F and 54.2 gr per lb the relative humidity is 41%, which is below the minimum of 47% required by the owner. Thus, entering air moisture content must be considerably higher than 53 gr per lb, so that the conditions specified for entering and leaving the coil are both incorrect.

Specifying the Right Conditions

To arrive at the correct solution, we plot the process on the psychrometric chart. See Fig. 1. A line is drawn connecting the inside condition (*R*) of 75 deg F and 50% rh with the outside design condition (*O*) of 95 deg dry bulb and 75 deg wet bulb.

Conditioned air entering the room must absorb 15,000 Btu per hr of latent heat while it absorbs 500,000 Btu per hr of sensible heat. The ratio, 15,000: 500,000, is 0.03. Multiplication of 0.03 by the constant 1.6 gives 0.048, which is the rise, in grains of moisture per pound of dry air, for each degree rise in temperature. (The constant 1.6 is the quotient of 1.08 and 0.67, two familiar constants, used above, that relate sensible and latent Btu loads to the requisite air quantities for conveying them.)

A line drawn through *R* with a slope of 0.048 gr per deg (approximately 1 grain per 20 deg) is the locus of all conditions at which air can enter the room and reach 75 deg and 50% rh while absorbing latent and sensible heat in the proportion in which they are being generated in the room. Actual plotting is done by locating point *C* at one gr per lb and 20 deg below the condition at *R*, which is 65 gr per lb and 75 deg. Thus, *C* is at 64 gr per lb and 55 deg, and line *RC* crosses the saturation curve just below 55 deg, which temperature is therefore the lowest at which conditioned air can be brought into the room.

With a 6-row coil of the type specified, about the lowest point which can be reached on line *RC* is 57 deg. (It would require more coil than the regular 6-row at 500 ft per min to reach 56 deg. It is questionable whether the extra coil is justified by the approximately 5% reduction in air requirement that would result.)

To absorb the room sensible heat of 500,000 Btu per hr with an 18 deg (57 deg to 75 deg) rise requires a circulation rate of 500,000/(18 × 1.08) = 25,700 cfm standard air. Thus, air circulation has to be increased

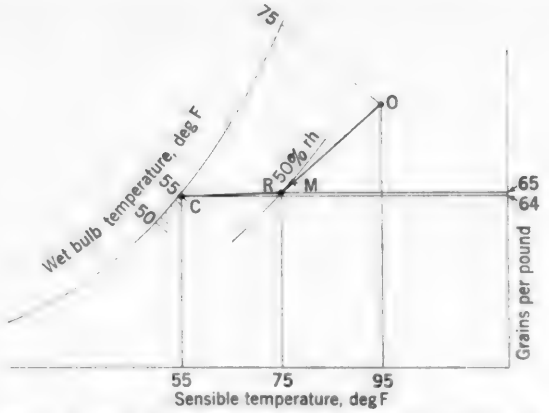


Fig. 1. Line *CR* is the locus of all conditions at which air can enter the space and reach the desired room condition, *R*, while absorbing sensible and latent heat in the correct proportion. Point *O* represents the outside design condition, *M* the condition entering the air conditioner.

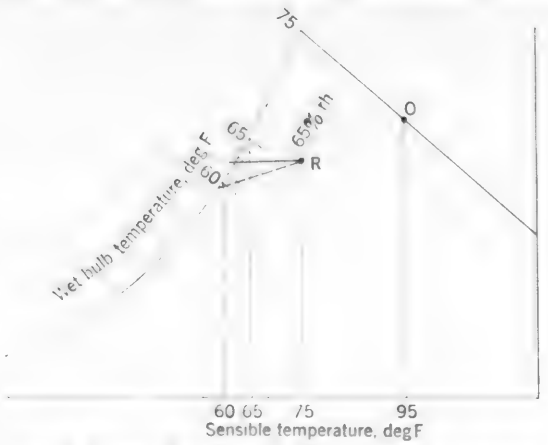


Fig. 2. Broken line through *R* shows what happens when, to avoid excessive coil surface due to high humidity requirement, a humidifier is used. Result is that air can be brought in at lower temperature and in smaller quantities. In this case, a hospital operating room, all outside air is used.

from 19,000 cfm, the air quantity originally specified, to 25,700 cfm.

Of the required 25,700 cfm, 3,000 cfm will be outside air and 22,700 will be recirculated air. Temperature of the mixture = 75 + (3,000/25,700) (95 − 75) = 77 deg. Locating 77 deg on line *RO* (Fig. 1) the condition entering the conditioner, point *M*, is found.

Specifications should have called for an air conditioning unit to take 25,700 cfm from 77 deg dry bulb and 63.8 deg wet bulb to 57 deg dry bulb and 55.7 deg wet bulb. Total heat removed would be about the same as originally specified, but only this specification would take care of both latent and sensible heat in the proportion generated.

Maintenance of Humidity in Operating Rooms

Air conditioning installations in hospital operating rooms are frequently wrongly specified. Although ambient room conditions will not be even close to an explosive mixture, the mixture of air and anesthetic at the patient's lungs and throat is sometimes in the explosive range. A spark could then be fatal.

To reduce the chance of sparks which result from static, relative humidity must be at least 55%. Since 65% can be maintained without discomfort, and further reduces the chance of static, some authorities recommend that the humidity be kept at about 65%.

In Fig. 2 a point is located at *R* for a room condition of 75 deg dry bulb and 65% rh, and at *O* for an outdoor condition of 95 deg dry bulb and 75 deg wet bulb. A solid line has been drawn from *R* to the saturation curve, with a very slight pitch down to indicate a small ratio of space latent to space sensible heat.

Conditioned air must enter the room at a condition represented by some point on that line. To keep required air to a minimum, that point should be as far to the left as possible. Even then, air cannot enter the room more than 11 or 12 deg below room temperature.

Since 100% outside air will probably be used, the coil must take air from condition *O* to 63 or 64 deg although the surface temperature of that part of the coil in contact with the leaving air is not below about 61.5 deg. A coil required to change air from 95 deg dry bulb and 75 deg wet bulb to about 63 deg dry bulb, 62.4 wet bulb would be rather deep, probably about 10 rows. If less, very low face velocity would be required.

A relatively simple way to handle this situation in an operating room is to install one or two humidifiers of the type that breaks up water into finely divided droplets and sprays it into the room as a fog which is readily evaporated. When this fog is injected about a foot in front of the air conditioning outlet, it evaporates quickly. (Distilled water will probably be required for the humidifier as any salts in the water result in a deposit on everything in the room.)

This humidifier changes part of the space sensible heat to space latent making the line through *R* slope down, somewhat like the broken line through *R*, Fig. 2. This makes it possible to bring air into the room at a lower temperature and in smaller quantities.

Sometimes, when there is a high space latent to space sensible ratio at full or part capacity, standard equipment cannot remove the latent without removing too much sensible. Then, reheat may be the only practical solution.

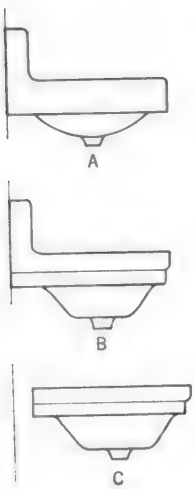
In this discussion it was seen that you can't buy air conditioning by the ton. Only when the principles of psychrometrics are brought into the picture can there be any surety that the system will do the job.

Inquiries for more information about the topics already covered in the Seminar or for technical information on other topics in his field, addressed to The Editor, are welcomed and will be forwarded to Mr. Ramsey.

Louis Blendermann on
PLUMBING and PIPING

Lavatory Installations

LAVATORIES are needed in great quantities in all types of buildings. Thus, there are lavatories of every size and description to satisfy particular needs or space conditions. These units range from the small compact corner lavatory to special lavatories that are built into a room space. Various types of trim are available and the lavatories can be equipped with soap dispensers or other devices. However, this discussion is confined to the common lavatory types that are installed in both large and small buildings.



◀ Fig. 1. Three basic types of lavatories: A—enameled lavatory; B—vitreous china high back; C—vitreous china deck type.

Types of Lavatories

The three basic types of lavatories, Fig. 1, are: Enamaled lavatory; vitreous china high back lavatory; vitreous china deck type lavatory. These will now be described.

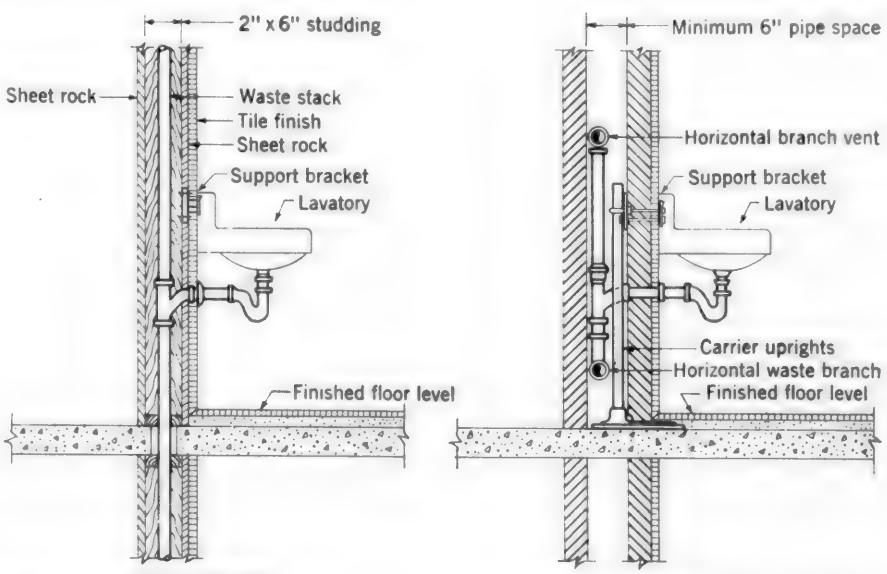
Enameled lavatory. This type is constructed of cast iron or steel and is furnished in several shapes and many colors. It is supported on a steel or cast iron bracket that is placed on the finished wall and is secured to the construction or other assemblies placed behind the construction. Lugs cast at the back of the lavatory engage slots in the bracket for support.

Vitreous china high back lavatory. This, too, comes in several shapes and sizes and many colors. It is supported on an exposed bracket which is secured to the construction, or to devices set behind the construction. This lavatory can also be supported on concealed arms secured to the construction or to devices set behind the construction.

Vitreous china deck type lavatory. Constructed of vitreous china, it can be furnished in several sizes and shapes and comes in many colors. This lavatory can be supported on concealed arms that are secured to the construction or to devices that are set behind the construction. The lavatory can also be supported on exposed type brackets although the concealed arms are more commonly used.

Enameled Lavatory

Roughing for the enameled lavatory easily fits minimum pipe spaces. Figure 2 shows two typical roughing installations. Arrangement 1 shows the lavatory installed as a single unit. The construction is 2-inch x 6-inch studding, faced on one side with a sheet rock finish and on the other side with a sheet rock and tiled finish. The 2 x 6-inch studding was shown for



▼ Fig. 2. Two installations of enameled lavatories.

ARRANGEMENT 1
Typical installation with the roughing contained in a pipe space of minimum dimensions

ARRANGEMENT 2
Typical installation of a battery of units with a pipe space of minimum dimensions

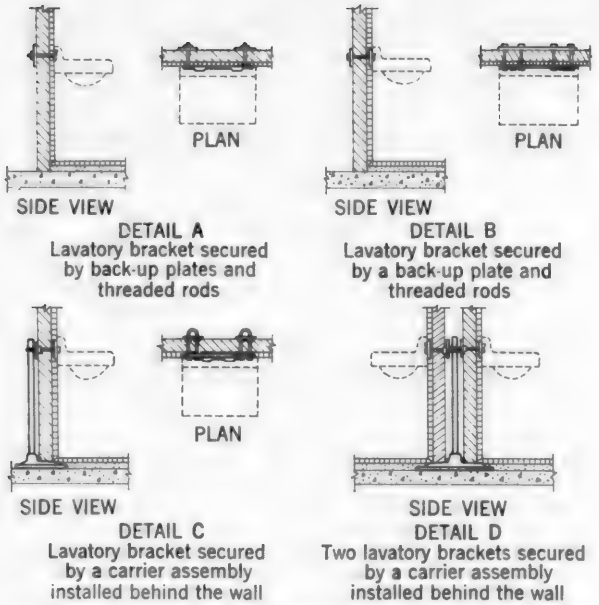

PLAN
SIDE VIEW
DETAIL A
Lavatory bracket secured by back-up plates and threaded rods
PLAN
SIDE VIEW
DETAIL B
Lavatory bracket secured by a back-up plate and threaded rods
PLAN
SIDE VIEW
DETAIL C
Lavatory bracket secured by a carrier assembly installed behind the wall
SIDE VIEW
DETAIL D
Two lavatory brackets secured by a carrier assembly installed behind the wall

Fig. 3. Various supporting devices that may be used with enameled lavatories.

example since this is the construction that would be required for a water closet that generally accompanies the lavatory.

The lavatory in this case is supported on a steel or cast iron bracket which in turn is secured by screws to the wood plank that is fastened to the stud construction. A steel plate is attached to the wood construction with threaded rods that extend out to engage and secure the bracket.

Arrangement (Fig. 2) illustrates the type construction that is encountered in larger buildings where batteries of lavatories are involved. It consists of glazed tile block, cinder or concrete construction. The wall surface in the rest room would be finished with tile. Any one of several other types of modern construction may be used with equal success. The pipe space is a minimum of 6 inches, since the roughing for a battery of lavatories is generally 2-inch horizontal piping with the individual connections 1½ or 2 inches.

The factors that create a need for the increase in size of the pipe space is the size of the vertical waste stack, vent stack and cold water risers. As these lines increase in size, the pipe space must be of wider proportions. If the lavatories are installed on the same wall with water closets or urinals, then the lavatory roughing will connect with the roughing for the other fixtures; the required pipe space in this event, would be the minimum 12-inch standard.

The device used to support the lavatory consists of an assembly of two feet, two uprights and a steel plate rigidly fastened to the uprights. Threaded rods extending from the steel plate engage and secure the steel or cast iron bracket that is placed on the finished wall to hold the lavatory.

Supporting Devices for Enameled Lavatories

Several types of supporting devices that may be used with enameled lavatories are illustrated in Fig. 3.

Detail *A* represents the steel or cast iron bracket set on the finished wall and secured to the construction by threaded rods that extend through the construction and engage the steel back-up plates set behind the construction.

Detail *B* shows the steel or cast iron bracket set on the finished wall with the threaded rods that extend through the construction to engage a steel plate placed behind the wall construction. This arrangement is suitable for wall construction of a flimsy nature since the steel plate distributes the bearing load over a greater wall surface. Sometimes a continuous steel plate is used when a battery of lavatories is mounted on wall surfaces of lightweight construction.

Detail *C* illustrates the method of support described in Arrangement 2, Fig. 2.

A back to back installation of lavatories is shown in Detail *D*. For support there is an assembly consisting of feet, uprights and steel plates.

Vitreous China High Back Lavatories

The roughing for the vitreous china back lavatories,

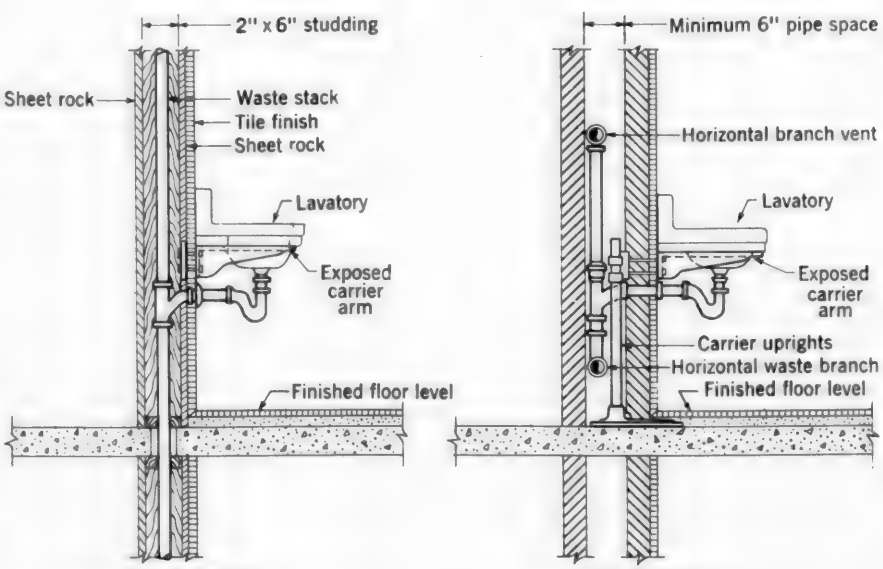


Fig. 4. Installations of vitreous china high back lavatories with the roughing contained in a pipe space of minimum dimensions.

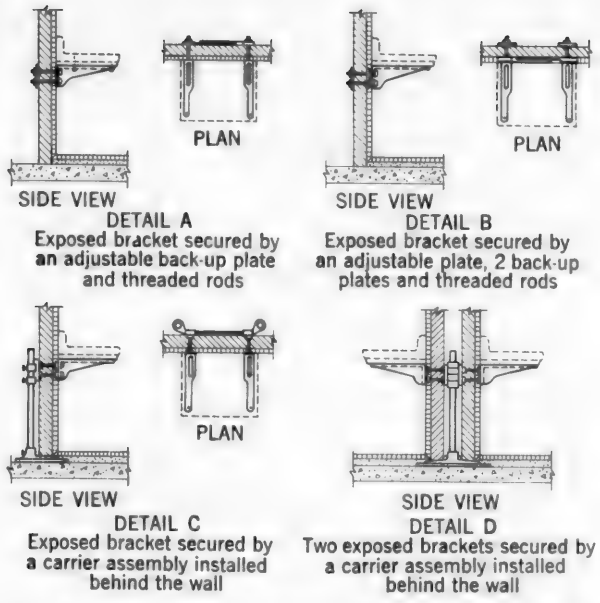

PLAN
SIDE VIEW
DETAIL A
Exposed bracket secured by an adjustable back-up plate and threaded rods
PLAN
SIDE VIEW
DETAIL B
Exposed bracket secured by an adjustable plate, 2 back-up plates and threaded rods
PLAN
SIDE VIEW
DETAIL C
Exposed bracket secured by a carrier assembly installed behind the wall
SIDE VIEW
DETAIL D
Two exposed brackets secured by a carrier assembly installed behind the wall

Fig. 5. Various supporting devices for vitreous china high back lavatories.

Fig. 4, easily fits a minimum pipe space.

Arrangement 1, Fig. 4, shows how the roughing is placed in the pipe space. The construction consists of 2 x 6-inch studding as would be required for water closets that are normally contained on the same wall.

The lavatory, in this instance, is supported on exposed bracket arms that are in turn attached by means of threaded rods to a steel plate rigidly secured to the studding. The lavatory is anchored to the exposed bracket arms by toggle bolts or other devices.

Arrangement 2 indicates how the roughing for a battery of lavatories can be installed in a pipe space of minimum proportions. Here again, the pipe space is 6 inches but is subject to an increase, dependent upon the size of the waste stack, vent stack and cold water risers. If the lavatory roughing is a component part of the roughing for water closets, then the pipe space would be 12-inch standard. The exposed bracket arms in this case are secured to an assembly of two feet, two uprights and adapter couplings that are secured to the uprights. Threaded rods extend out from the adapter plates to engage and anchor the bracket arms in place. Once again, toggle bolts or other devices are utilized to secure the lavatory to the exposed bracket arms.

Supporting Devices

Several types of supporting devices may be used with vitreous china high back lavatories, as detailed in Fig. 5.

Detail *A* of the figure shows the exposed bracket arms secured to the construction by means of threaded rods that fasten the exposed bracket arms to an adjustable plate of cast iron or steel placed behind the wall.

Detail *B* shows the exposed bracket arms attached to an adjustable plate placed in the construction at the room side and secured by means of threaded rods to steel plates set at the back of the wall construction.

Detail *C* illustrates the method of support described in Arrangement 2 of Fig. 4.

Detail *D* shows a back to back installation of lavatories and for support, an assembly consisting of feet, uprights, adapter couplings and exposed bracket arms.

Vitreous China Deck Type Lavatories

Roughing for the vitreous china deck type lavatories easily fits minimum pipe space dimensions as detailed in Fig. 6.

Arrangement 1 of Fig. 6 shows the roughing installed in the minimum space offered by 2 x 6-inch stud construction. Here the lavatory is shown as a single unit. The 2 x 6-inch construction has been shown since this is the space required for water closet roughing usually placed on the same wall as the lavatory.

In this case the lavatory is supported on concealed arms which are in turn secured to an adapter plate that is rigidly affixed to the stud construction. The concealed arms slip into holes that have been provided at the back of the lavatory. Leveling screws are in-

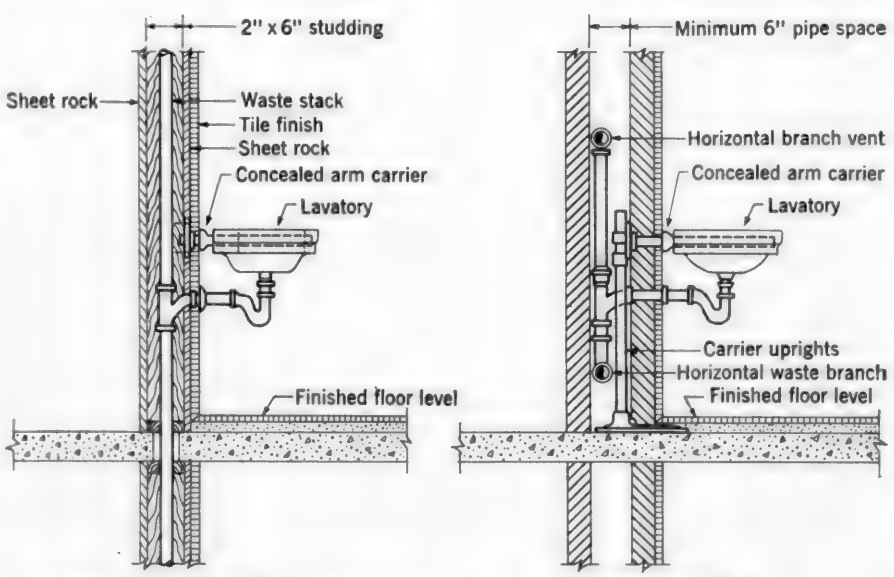


Fig. 6. Installations of vitreous china deck type lavatories with the roughing contained in a pipe space of minimum dimensions.

ARRANGEMENT 1
Typical installation with the roughing contained in a pipe space of minimum dimensions

ARRANGEMENT 2
Typical installation of a battery of units with a pipe space of minimum dimensions

corporated on the concealed arms to align the lavatory. Also a locking device is located on the concealed arms to anchor the lavatory in place. Access to the leveling screws and anchoring device is provided by holes in the underside of the lavatory. The deck type lavatory is set approximately 2 inches away from the wall. Thus, the portion of the concealed arms which would normally be exposed is hidden by a chrome plated escutcheon that fits between the wall and the back of the lavatory.

Arrangement 2 shows the vitreous china deck type lavatories installed in a battery arrangement. The pipe space is 6 inches wide as it would be used for the battery installations. This pipe space is subject to an increase dependent upon the size of the vertical waste stack, vent stack and cold water risers that are used when water closets or urinals are installed on the same wall. The required pipe space dimension would then be the standard 12 inches.

Here, each of the lavatories in the battery arrangement are supported on concealed arms which are in turn secured to an assembly of two feet, two uprights and two adapter couplings.

Supporting Devices for Deck Type Lavatories

Several devices that may be utilized to support vitreous china deck type lavatories are shown in Fig. 7.

Detail *A* of this figure shows how concealed arms can be secured to the construction by an adjustable adapter plate set behind the wall construction. A lock nut at the finished wall anchors the concealed arm.

Detail *B* shows the concealed arms secured to the construction by means of an adjustable adapter plate set in the finished wall with steel back-up plates at the rear of the construction.

Detail *C* illustrates in detail the method of support described in Arrangement 2 of Fig. 6.

Detail *D* shows how back to back lavatories may be supported on concealed arms which are in turn, fastened to an assembly of two feet, two uprights and adapter couplings.

The many manufactured devices that are available make possible a very broad selection for the engineer from which to choose.

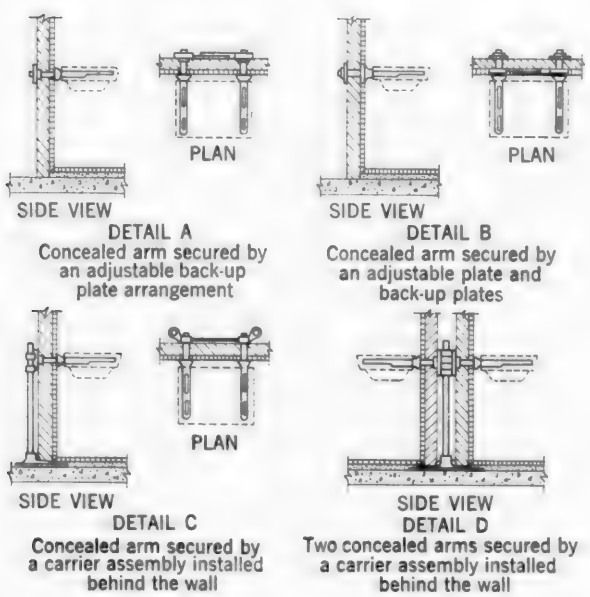

PLAN
SIDE VIEW
DETAIL A
Concealed arm secured by an adjustable back-up plate arrangement
PLAN
SIDE VIEW
DETAIL B
Concealed arm secured by an adjustable plate and back-up plates
PLAN
SIDE VIEW
DETAIL C
Concealed arm secured by a carrier assembly installed behind the wall
SIDE VIEW
DETAIL D
Two concealed arms secured by a carrier assembly installed behind the wall

Fig. 7. Various supporting devices for vitreous china deck type lavatories.

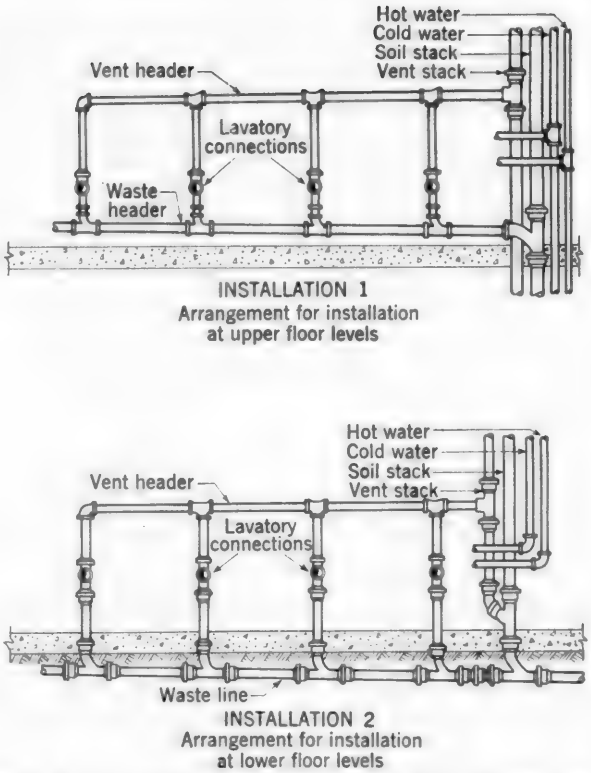


Fig. 8. Two arrangements of roughing for a battery of lavatories.

Installation of Lavatory Roughing

Two typical arrangements of lavatory roughing are illustrated in Fig. 8.

One shows a typical arrangement of roughing that might be employed for the upper floor levels in a building. Here the roughing is installed above the floor slab. The roughing with the exception of the vertical waste and vent stack, is of threaded pipe and fittings. The horizontal waste piping is run above the slab and connects with the vertical waste stack as shown. The individual vent lines are caulked into the fittings that receive the waste from the lavatories. This arrangement can be used with all the lavatories described.

The other is a typical installation of roughing at the ground or lowest floor level in the building. Here the horizontal waste line is below the floor slab and is of cast iron hub and spigot pipe and fittings. The piping up to and including the lavatory waste connection, is also of the hub and spigot pipe and fittings. The vent header and individual vents are of threaded pipe.

Galvanized steel pipe, galvanized wrought iron pipe, copper pipe or cast iron hub and spigot piping all may be used for the installation. The engineer will select the materials as well as the particular method of roughing arrangement he favors.

Lead-Asbestos Pads Isolate Cooling Tower Vibrations

AL LEICHTMAN

Weinberger, Frieman, Leichtman & Quinn
Consulting Engineers, New York, N. Y.

Fig. 1. Cooling tower is mounted on lead pads to isolate vibration from building. Pads foot directly on beams.

THE COOLING TOWER of the new 34-story Grolier Building in New York City is a typical skyscraper installation. With its three 60-hp, 1800-rpm motors, with spiral bevel gears driving three 12-bladed adjustable pitch fans at 202 rpm and a 6,000-gpm water pump, vibrations are initiated which, if not isolated, would be a considerable source of annoyance to office workers below. High winds, on occasion rushing through the tower slats, intensify these vibrations.

It was decided to isolate the tower from the building by separating the supporting columns of the tower from the structural beams of the building. A material was required that would have the capacity to absorb the tower's vibrations, yet have sufficient strength to support its 205,000-lb load. A combination of lead and asbestos was found to be suitable.

Why Lead-Asbestos

Our choice of lead and asbestos was based on the successful adaptation of anti-vibration pads of asbestos sealed in lead in isolating even heavier vibrations in such structures as the Waldorf-Astoria Hotel, the Union Carbide Building and other buildings directly over the New York Central Railroad tracks; the Bell Telephone Laboratories, with railroad tracks running right between the second and fifth floors, and in building construction above the New York City subway system.

Tests conducted at Columbia University many years ago proved that lead and asbestos, in combination, had superior isolation qualities. The tests also showed that together they damped better than either material alone. Both materials are easily workable. Lead is highly resistant to corrosion and impervious to water which makes it an excellent seal, while asbestos is equally noted for its chemical resistance qualities which assure long-life for the pads. An additional advantage of the combination pad is that it can carry heavy loads, a quality rare among isolating materials.

Durability of lead-asbestos pads was demonstrated when the old Marguery Hotel in New York was razed to make way for the new Union Carbide Building. Lead pads on which the hotel had rested for more than 40

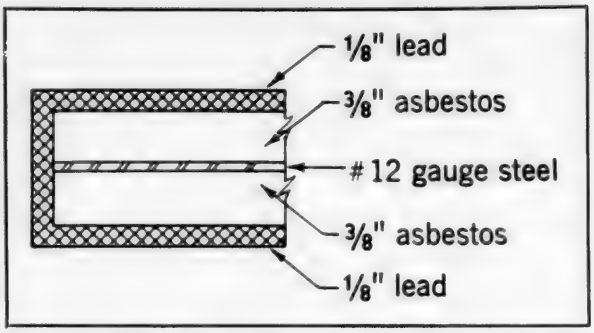


Fig. 2. Basic structure of isolating pad.

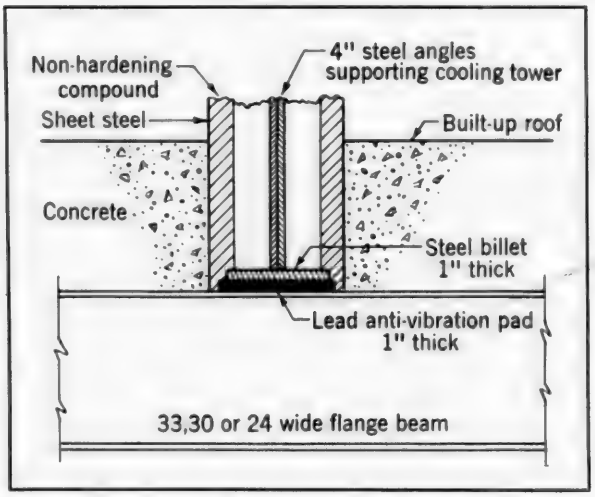


Fig. 3. Pads are installed between the base of the cooling tower's supporting columns and the actual structural steel as shown in drawing.

years were found to be in almost perfect condition, with practically no corrosion or dimensional change.

Lead pads had never been tried under a cooling tower. Would the pads be effective—since some of the vibration from the tower would be of much higher frequency than that of the railroads? Since the cost of installing the pads was relatively negligible, the experiment was justified.

Pad Specifications

Pads installed under the cooling tower are fabricated like sandwiches—two layers of ⅜-inch asbestos placed against a layer of #12 gage steel, sealed in ⅛-inch lead under pressure of 200 psi. There are ten pads of 1-inch thickness in all—one for each of the tower's ten supporting steel angle columns. Surface dimensions of the corner pads are 8 x 8 inches; those of the other pads, naturally subjected to greater load, are 8 x 14 inches. Thus, total anti-vibration surface of the ten pads is 928 square inches; pressure is about 220 psi.

Installation

The ten pads were laid directly on the building's wide flange construction beams while the building was still in its construction frame stage. Then one-inch

Fig. 4. Architect's rendering of new thirty-four story Grolier office building at 575 Lexington Avenue in New York City.

steel billets were laid over the pads to distribute the weight, and the tower's 4-inch angle columns bolted directly to these billets.

Supporting angle columns of the tower were also isolated from the concrete roof by containing them in pitch pockets of non-hardening mastic compound. Pitch pockets extended upward from the structural beams to about 1½ inches above the roof surface. This calking procedure also insures against water leaking under the angle columns and into the building.

Costs Kept Down

Economy of using the pads is apparent when compared to the alternative cost of constructing the concrete roof thick enough to absorb the vibrations. Further cost saving in effected by installing the pads, billets, and tower supporting columns during the building's construction frame stage, rather than after the concrete roof had been laid. This procedure eliminates time and cost of recalling the steel workers and their equipment to install the tower's footings after the roof has been laid. Instead, all is in readiness for the cooling tower to be attached to its supporting columns, already in place, once the roof was completed.

Absence of vibrations on all floors of the building, even when the cooling tower is operating on windy days, is evidence of the lead-asbestos pads' ability to absorb effectively the cooling tower vibrations.

Sylvan and Robert L. Bien, New York City, were the architects of the Grolier Building. The author's firm was the consulting engineers. Owner-builder was Sam Minskoff & Sons, Inc. Pads were supplied by John F. Abernethy and Co., Brooklyn, N. Y.

Air Conditioning, Heating and Ventilating Index to Feature Articles – 1960

In this index, grouped by broad subject matter and by author, only feature articles are included excepting that Reference Data Sheets and Detail Sheets are also listed. The abbreviation *Ref. Sec.* indicates Reference Section.

Copies of this index are available on request from Air Conditioning, Heating and Ventilating, 93 Worth St., New York 13, N. Y.

INDEX BY SUBJECT

AIR CLEANING AND HANDLING

Access Doors in Ducts (Detail Sheet), Nov. 1960, 89-90.

Activated Carbon Filters Control Radioactive Vapors, T. T. Porembski, Nov. 1960, 97-98.

Air Cleaning and Purification, May, 1960, 71-72.

Air Distribution for Air Conditioning (Ref. Sec.), J. W. Markert, Mar. 1960, 75-83.

Air Distribution in Large Buildings, Control Systems for (Ref. Sec.), Sept. 1960, 73-84.

Centrifugal Fan Application Guide, C. J. Trickler, Part 1—Which Fan Will Work Best?, April, 1960, 55-63; Part 2—Is the System Correctly Designed?, May, 1960, 85-89; Part 3—Will the Fan Be Noisy?, June 1960, 71-74; Part 4—Will the Fan Vibrate?, July, 1960, 73-76; Part 5—How Much Air is Delivered, Aug. 1960, 89-93.

Chart Speeds Orifice Sizing, R. Brief, Aug. 1960, 57-60.

Comparative Cost of High Velocity Dual Duct Systems, N. S. Shataloff, June, 1960, 55-61.

Controlling Airborne Radioactivity During "Hot" Cleanup, J. M. Ruddy, Feb. 1960, 66-69.

Corporate Dynamism Required Flexible Air Distribution System, Mar. 1960, 96-97.

Detectors and Test Kits for Air Sampling, J. B. Gisclard, Sept. 1960, 89-92.

High Velocity Double Duct Systems, N. J. Janisse, Feb. 1960, 70-73.

How to Balance an Air System, H. C. Reh, Oct. 1960, 69-71.

Methods for Hanging Ducts, W. C. Janes, Mar., 1960, 89-90.

Plastic Ventilation Products (Ref. Sec.), H. M. Englund, Oct. 1960, 75-84.

Pressure Loss Due to Abrupt Expansion, (Data Sheet), Nov. 1960, 87.

Reverse-Jet Filters, K. J. Caplan, Oct. 1960, 62-65.

Room Air Distribution (Ref. Sec.), Nov. 1960, 69-85.

Volume Dampers; Multiple Blade Volume Dampers (Detail Sheet), Dec. 1960, 84-85.

AIR CONDITIONING AND REFRIGERATION

Air Conditioning, Air Distribution for (Ref. Sec.), Mar. 1960, 75-83.

Air Conditioning Budget Price Data for Office Buildings, M. J. Wilson, Nov. 1960, 94-96.

Air Conditioning for a Multi-Story Bank Building, H. B. Swygert, Jr., Oct. 1960, 96-98.

Air Conditioning Operationg Costs of Multi-story Office Buildings, M. Backer and G. Furgiuele, Sept. 1960, 57-62.

Air Conditioning and Heating the Supermarket (Ref. Sec.), W. A. Zumbiel, May, 1960, 73-80.

Air Conditioning Hospitals (Ref. Sec.), I. S. Herbst, June, 1960, 75-82.

Air Conditioning System Design for Churches, Theaters and Auditoriums (Ref. Sec.), J. F. Schmidt, Jan. 1960, 87-97.

Air Conditioning the Variety Store (Ref. Sec.), A. Rose and S. L. Sloan, Jr., Feb. 1960, 79-87.

All Weather Comfort Standard, May, 1960, 57-59.

Alleys Supplied with Conditioned Air Through Concrete Ducts in Roof Valleys, S. Wheler, June, 1960, 62-63.

Applying Weather Data to Greenhouse Cooling, C. P. Hedlin, April, 1960, 76-78.

Better Methods for Evaluating Hermetic Motor Insulation, J. L. Ditzler, April, 1960, 64-68.

Chemical Conditioners Called Matchless for Match Production, W. C. Delph and J. L. Glim, Dec. 1960, 88-90.

Coil Performance Solutions Without Trial and Error, T. Kusuda, Jan. 1960, 73-80.

Comparative Cost of High Velocity Dual Duct Systems, M. S. Shataloff, June, 1960, 55-61.

Computer Room Air Conditioning: An Improved Method, G. C. Lewis, July, 1960, 100.

Corporate Dynamism Required Flexible Air Distribution System, Mar. 1960, 96-97.

Distilleries Use Liquor Chilling, C. S. Cave, June, 1960, 87-89.

Estimating Guide-Refrigeration and Air Conditioning (Data Sheets), Jan. 1960, 101-102; Feb. 1960, 91-92; Mar. 1960, 85-86.

Evaluation of School Air Conditioning (Special Report), Aug. 1960, 77-84

Fan-Coil Units Provide Year-Round Comfort for Apartment Dwellers, N. Feder, Sept. 1960, 98-99.

Foreign Summer Design Temperatures (Data Sheet), Dec. 1960, 81-82.

Gas Air Conditioning Solves Basic Printing Problems, L. K. Lucas, Sept. 1960, 100-101.

Heat Pump Hermetic Motors Require Special Protection. R. S. Stewart and G. L. Biehn, Feb. 1960, 74-78.

High Velocity Double Duct Systems, N. J. Panisse, Feb. 1960, 70-73.

How to Balance an Air System, H. C. Reh, Oct. 1960, 69-71.

Improving Piping Hookups for Refrigerant Discharge Lines, J. R. Harnish, Feb. 1960, 95-98.

Measuring Space Temperatures for Comfort Control, H. Nordeen, Sept. 1960, 95-96.

Methods for Control of Reciprocating Water Chillers, R. Stamm, Part 1—Nov. 1960, 59-65; Part 2—Dec. 1960, 61-66.

Nomograph for the Temperature-Humidity Index, H. A. Dodge, Mar. 1960, 84.

Practical Selection of Sound Control Treatment, J. W. Overend, Aug. 1960, 63-66.

Refrigerant Liquid Line Piping, J. R. Harnish, April, 1960, 91-95.

Refrigerant Piping (Detail Sheets), June, 1960, 85-86; July, 1960, 91-92.

Refrigerant Piping for Flooded Water Coolers, J. R. Harnish, May, 1960, 66-69.

Refrigerant Piping for Parallel Evaporators, J. H. Harnish, Jan. 1960, 105-108.

Refrigerant Piping Hookups for Parallel Compressors, J. R. Harnish, Mar. 1960, 69-73.

Residential Cooling Load Calculation, Dec. 1960, 54-65.

Risers in Mullions Serve Induction Units, April, 1960, 96-97.

Selecting Air Conditioning Systems for Specific Applications, M. J. Wilson, Oct. 1960, 72-74.

Seven Packaged Units Net Bank Better Cooling at Less Cost, July, 1960, 101-102.

Specify Coil Performance!, J. R. Welch, Sept. 1960, 68-69.

Specification and Design Seminar, M. Ramsey, Holding Comfort Conditions at Low Loads, Dec. 1960, 85-87.

Split Systems for Comfort, S. A. Littmann, Mar. 1960, 59-60.

Summer-Winter Changeover — Simplified, L. H. V. Smith, Sept. 1960, 93-94.

Unit Ventilators Smooth Transition to Year-Round School Comfort, Jan. 1960, 81-82.

Water for Heat Pump Pre-Conditions Ventilation Air; One Well Serves in Winter, a Deeper One in Summer, A. W. Krause, May, 1960, 90-92.

When and where to use Liquid-Suction Heat Interchangers, L. N. Brown, June, 1960, 64-65.

Wichita School Heat Pump, C. E. Wagner, April, 1960, 72-74.

Winterizing Chilled Water Systems, H. D. Goodman, Nov. 1960, 91-93.
Wiring Diagram-Refrigeration Compressors (Detail Sheets), Jan. 1960, 103-104; Feb. 1960, 89-90.

BUILDING TYPES

Apartment Dwellers, Fan-Coil Units Provide Year-Round Comfort for, Sept. 1960, 98-99.
Air Conditioning for a Multi-Story Bank Building, H. B. Swygert, Jr., Oct. 1960, 96-98.
Bowling Alleys Supplied with Conditioned Air through Concrete Ducts in Roof Valleys, S. Wheeler, June, 1960, 62-63.
Churches, Theaters and Auditoriums, Air Conditioning System Design for, (Ref. Sec.), J. F. Schmidt, Jan. 1960, 87-97.
Commercial and Industrial Buildings, Hydronic Heating Design for (Ref. Sec.), R. H. Emerick, Dec. 1960, 67-80.
Computer Room Air Conditioning, July, 1960, 100.
Distilleries Use Liquor Chilling, C. S. Cave, June, 1960, 87-89.
Greenhouse Cooling, Applying Weather Data to, C. P. Hedlin, April, 1960, 76-78.
Hangars, Jet Age, Get Radiant Heating, Snow Melting, Aug. 1960, 98.
Hospitals, Air Conditioning (Ref. Sec.), I. S. Herbst, June, 1960, 75-82.
Industrial Building Operaters' Problems, J. Vonderheid, Aug. 1960, 67-68.
Large Buildings, Control Systems for Air Distribution in (Ref. Sec.), J. E. Haines, Sept. 1960, 73-84.
Match Production, Chemical Conditioners Called Matchless for, W. C. Delph and J. L. Glim, Dec. 1960, 88-90.
Office Buildings, Air Conditioning Budget Price Data for, M. J. Wilson, Nov. 1960, 94-96.
Office Buildings, Air Conditioning Operating Costs of Multi-Story, M. Backer and G. Furgiuele, Sept. 1960, 57-62.
Printing Problems, Gas Air Conditioning Solves Basic, L. K. Lucas, Sept. 1960, 100-101.
Risers in Mullions Serve Induction Units, April, 1960, 96-97.
School Air Conditioning, Evaluation of (Special Report), Aug. 1960, 77-84.
School Comfort, Unit Ventilators Smooth Transition to Year-Round, Jan. 1960, 81-82.
School Heat Pump, Wichita, C. E. Wagner, April, 1960, 72-74.
School, Which is the Best Heating and Ventilating System for this?, J. S. Minges, Mar. 1960, 61-64.
Store, Variety, Air Conditioning the (Ref. Sec.), A. Rose and S. L. Slian, Jr., Feb. 1960, 79-87.
Supermarket, Air Conditioning and Heating the (Ref. Sec.), W. A. Zumbiel, May, 1960, 73-80.
Surgical Suites, Can You Safely Select Electronic Temperature Controls for?, G. J. Thomas, July, 1960, 67-69.

CHILLED WATER

Methods for Control of Reciprocating Water Chillers, R. Stamm, Part 1—Nov. 1960, 59-64; Part 2—Dec. 1960, 61-66.
Refrigerant Piping for Flooded Water Coolers, J. R. Harnish, May, 1960, 66-69.
Winterizing Chilled Water Systems, H. D. Goodman, Nov. 1960, 91-93.

COILS

Coil Performance Solutions Without Trial and Error, T. Kusuda, Jan. 1960, 73-80.
Fan-Coil Units Provide Year-Round Comfort for Apartment Dwellers, N. Feder, Sept. 1960, 98-99.
Refrigerant Piping for Parallel Evaporators, J. R. Harnish, Jan. 1960, 105-108.
Specify Coil Performance!, J. R. Welch, Sept. 1960, 68-69.
Tips on Automatic Control of Fan-Coil Units, J. Schwartz, April, 1960, 69-71.

COMPRESSORS

Refrigerant Piping Hookups for Parallel Compressors, J. R. Harnish, Mar. 1960, 69-73.
Wiring Diagram—Refrigeration Compressors (Detail Sheets), Jan. 1960, 103-104; Feb. 1960, 89-90.

COMPUTER AREAS

Computer Room Air Conditioning: An Improved Method, G. C. Lewis, July, 1960, 100.
Tubular Centrifugal Fans Ease Stringency of Computer Room Conditioning Requirements, Aug. 1960, 96-97.

CONTROLS

Can You Safely Select Electronic Temperature Controls for Surgical Suites?, G. J. Thomas, July, 1960, 67-69.
Control of Reciprocating Water Chillers, Methods for, R. Stamm, Part 1 Nov. 1960, 59-64; Part 2—Dec. 1960, 61-66.
Control System Guarantees Supply From Distant Water Mains, J. Nachbar, Feb. 1960, 61-65.
Control Systems for Air Distribution in Large Buildings (Ref. Sec.), J. E. Haines, Sept. 1960, 73-84.
Design of Pneumatic Control Centers (Ref. Sec.), R. J. Caffrey, Aug. 1960, 69-75.
Measuring Space Temperatures for Comfort Control, H. Nordeen, Sept. 1960, 95-96.
Tips on Automatic Control of Fan-Coil Units, J. Schwartz, April, 1960, 69-71.

COSTS

Air Conditioning Operating Costs of Multi-story Office Buildings, M. Backer and G. Furgiuele, Sept. 1960, 57-62.
An Economic Evaluation of Heat Rejection Methods, M. J. Wilson, July, 1960, 70-72.
Check Lists and Bid Forms for Contractors, (Data Sheet), Oct. 1960, 85, 86.
Comparative Cost of High Velocity Dual Duct Systems, N. S. Shataloff, June, 1960, 55-61.
Estimating Guide—Refrigerating and Air Conditioning (Data Sheets), Jan. 1960, 101-102; Feb. 1960, 91-92; Mar. 1960, 85-86.
Handling Fan Heat Loads at Minimum Cost, S. Daryanani, Aug. 1960, 61-62.
Price Data for Office Buildings, Air Conditioning Budget M. J. Wilson, Nov. 1960, 94-96.
Seven Packaged Units Net Bank Better Cooling at Less Cost, July, 1960, 101-102.

DATA SHEETS

Check Lists and Bid Form for Contractors, Oct. 1960, 85-86.
Estimating Guide-Refrigeration and Air Conditioning, Jan. 1960, 101-102; Feb. 1960, 91-92; Mar. 1960, 85-86.
Flow of Water in Circular Sewers, April, 1960, 87-88; May, 1960, 81-82; June, 1960, 83-84; July, 1960, 88-89; Aug. 1960, 85.
Foreign Summer Design Temperatures, Dec. 1960, 81-82.
Nomograph for Finding Fan Horsepower: Nomograph for Finding Actual Air Capacity, Sept. 1960, 85-86.
Nomograph for Finding Pump Horsepower, Nov. 1960, 88.
Pressure Loss Due to Abrupt Expansion, Nov. 1960, 87.
Wheel Load Transmitted to Pipe Under a Road, Aug. 1960, 86.

DEGREE DAYS

Degree Days for 147 Cities: For Nov. 1959, Jan. 1960, 120; for Dec. 1959, Feb. 1960, 104; for Jan. 1960, Mar. 1960, 98; for Feb. 1960, April, 1960, 102; for Mar. 1960, May, 1960, 100; for April, 1960, June, 1960, 103; for May, 1960, July, 1960, 112-113; for June, 1960, Aug. 1960, 104-105; for Sept. and Oct. 1960, Dec., 99-100.

DETAIL SHEETS

Access Doors in Ducts, Nov. 1960, 89-90.
Gas-Fired Unit Heaters, Aug. 1960, 87-88.
Piping for Heat Recovery Systems, April, 1960, 89-90.
Piping for Hot Water Space Heating Systems, Mar. 1960, 87-88.
Refrigerant Piping, June, 1960, 85-86; July, 1960, 91-92.
Sprinkler Systems, Oct. 1960, 87-88.
Steam Heating Systems, May, 1960, 83-84.
Volume Dampers; Multiple Blade Volume Dampers, Dec. 1960, 84-85.
Water Coil Piping, Sept. 1960, 87-88.
Wiring Diagram—Refrigeration Compressors (Detail Sheet), Jan. 1960, 103-104; Feb. 1960, 89-90.

DISTRICT HEATING

District Steam Industry Expands, A. F. Metzger, Part 1, Aug. 1960, 94-95; Part 2, Sept. 1960, 70-72.

FANS AND BLOWERS

Centrifugal Fan Application Guide, C. J. Trickler, Part 1—Which Fan Will Work Best?, April, 1960, 55-63; Part 2—Is the System Correctly Designed?, May, 1960, 85-89; Part 3—Will the Fan be Noisy?, June, 1960, 71-74; Part 4—Will the Fan Vibrate?, July, 1960, 73-76; Part 5—How Much Air is Delivered?, Aug. 1960, 89-93.

Handling Fan Heat Loads at Minimum Cost, S. Daryanani, Aug. 1960, 61-62.
Nomograph for Finding Fan Horsepower; Nomograph for Finding Actual Air Capacity (Data Sheet), Sept. 1960, 85-86.
Power Venting of Gas Appliances, J. Paul Jones, May, 1960, 53-56.
Selection of Induced Draft Fans for Heating Boilers, H. A. Reynolds, Dec. 1960, 51-53.
Tubular Centrifugal Fans Ease Stringency of Computer Room Conditioning Requirements, Aug. 1960, 96-97.

FUNDAMENTALS

The Engineering Significance of Normal Atmospheric Pressure, J. K. Brasch, July, 1960, 93-97.

GAS HEATING AND AIR CONDITIONING

Flameless Gas Heating, Oct. 1960, 100.
Gas Air Conditioning Solves Basic Printing Problems, L. K. Lucas, Sept. 1960, 100-101.
Gas-Fired Unit Heaters (Detail Sheet), Aug. 1960, 87-88.
Power Venting of Gas Appliances, J. Paul Jones, May, 1960, 53-56.

HANGARS

Jet-Age Hangars Get Radiant Heating, Snow Melting, Aug. 1960, 98.

HEAT PUMPS

Heat Pump Hermetic Motors Require Special Protection, R. S. Stewart and G. L. Biehn, Feb. 1960, 74-78.
Water for Heat Pump Pre-Conditions Ventilation Air; One Well Serves in Winter, a Deeper One in Summer, A. W. Krause, May, 1960, 90-92.
Wichita School Heat Pump, C. E. Wagner, April, 1960, 72-74.

HEATING AND HEAT TRANSFER

An Economic Evaluation of Heat Rejection Methods, M. J. Wilson, July, 1960, 70-72.
Design and Application for Electric Heat (Ref. Sec.), P. Sporn and E. R. Ambrose, July, 1960, 77-88.
The Engineer Looks at Direct Fired Radiant Heating, H. I. Miller, Jr., Mar. 1960, 65-68.
Flameless Gas Heating, Oct. 1960, 100.
Flexible Hose Fuel and Steam Connections Improved Boiler Efficiency, Mar. 1960, 97.
Gas Fired Unit Heaters (Detail Sheet), Aug. 1960, 87-88.
Handling Fan Heat Loads at Minimum Cost, S. Daryanani, Aug. 1960, 61-62.
Heating the Supermarket, Air Conditioning and (Ref. Sec.), W. A. Zumbiel, May, 1960, 73-80.
Hydronic Heating Design for Commercial and Industrial Buildings (Ref. Sec), R. H. Emerick, Dec. 1960, 67-80.
Jet-Age Hangars Get Radiant Heating, Snow Melting, Aug. 1960, 98.
Piping for Heat Recovery Systems (Detail Sheet), April, 1960, 89-90.
Piping for Hot Water Space Heating Systems (Detail Sheet), Mar. 1960, 87-88.
Selection of Induced Draft Fans for Heating Boilers, H. A. Reynolds, Dec. 1960, 51-53.
Single-Pipe Hot Water Heating, I. Livtchak, Part 1 — Classification, Pipe Sizing, and Control, May, 1960, 60-63; Part 2—The Panyushkin Slide Rule, June, 1960, 66-69.
Steam Heating Systems (Detail Sheet), May, 1960, 83-84.
Successful Radiant Heating with Thermoplastic Pipe, Oct. 1960, 99-100.
Three Duct Furnaces Solve Make-up Air Problem, Nov. 1960, 99.
Transmission of Heat and Vapor through Sandwich Panels, Jan. 1960, 83-86.
Turbo-Generators Supply Steam for High Temperature Water Heating, E. G. Hansen and N. E. Pearsall, June, 1960, 90-93.
Which is the Best Heating and Ventilating System for this School?, J. S. Minges, Mar. 1960, 61-64.
Wichita School Heat Pump, C. E. Wagner, April, 1960, 72-74.

MOTORS

Better Methods for Evaluating Hermetic Motor Insulation, J. L. Ditzler, April, 1960, 64-68.
Heat Pump Hermetic Motors Require Special Protection, R. S. Stewart and G. L. Biehn, Feb. 1960, 74-78.

PIPING

Flow of Water in Circular Sewers (Data Sheet), April, 1960, 87-88; May, 1960, 81-82; June, 1960 83-84; July, 1960, 88-89; Aug. 1960, 85.
Forged Steel Flanges, E. F. Harrington, Oct. 1960, 89-95.
Improving Piping Hookups for Refrigerant Discharge Lines, J. R. Harnish, Feb. 1960, 95-98.
Optimizing Primary Coolant Piping for Nuclear Power Plants, H. Gitterman, Oct. 1960, 66-68.
Piping and Plumbing, L. Blendermann, **Indirect Waste Receptor Applications,** Jan. 1960, 114-118; **Cleanouts for Underground Drainage Lines,** Feb. 1960, 99-102; **Upper Floor Cleanouts,** Mar. 1960, 92-95; **Water Accumulation Around Buildings,** April, 1960, 98-101; **Piping Sleeves,** May, 1960, 95-99; **Exterior Sand Traps,** June, 1960, 94-98; **Interior Sand and Sediment Traps,** July, 1960, 104-107; **Gasoline Station Drainage,** Aug. 1960, 100-103; **Floor Mounted Water Closet Installations,** Sept. 1960, 102-105; **Wall Mounted Water Closet Installations,** Oct. 1960, 101-104; **Floor Mounted Urinal Installations,** Nov. 1960, 100-103; **Wall Mounted Urinal Installations,** Dec. 1960, 91-94.
Piping for Heat Recovery Systems (Detail Sheet), April 1960, 89-90.
Piping for Hot Water Space Heating Systems (Detail Sheet), Mar. 1960, 87-88.
Recirculating Water Systems and Mechanical Pump Seals, D. B. Gardner, Dec. 1960, 57-59.
Refrigerant Liquid Line Piping, J. R. Harnish, April, 1960, 91-95.
Refrigerant Piping for Flooded Water Coolers, J. R. Harnish, May, 1960, 66-69.
Refrigerant Piping Hookups for Parallel Compressors, J. R. Harnish, Mar. 1960, 69-73.
Refrigerant Piping for Parallel Evaporators, J. R. Harnish, Jan. 1960, 105-108.
Single-Pipe Hot Water Heating, I. Livtchak, Part 1—Classification, Pipe Sizing, and Control, May, 1960, 60-63; Part 2—The Panyushkin Slide Rule, June, 1960, 66-69.
Sprinkler Systems (Detail Sheet), Oct. 1960, 87-88.
Successful Radiant Heating with Thermoplastic Pipe, Oct. 1960, 99-100.
Water Coil Piping (Detail Sheet), Sept. 1960, 87-88.
Wheel Load Transmitted to Pipe Under a Road (Data Sheet), Aug. 1960, 86.
When and where to use Liquid-Suction Heat Interchangers, L. N. Brown, June, 1960, 64-65.

PLUMBING

Control System Guarantees Supply From Distant Water Mains, J. Nachbar, Feb. 1960, 61-65.
Display Fountains (Ref. Sec.), V. Mandracchia, April, 1960, 79-86.
Flow of Water in Circular Sewers (Data Sheets), April, 1960, 87-88; May, 1960, 81-82; June, 1960, 83-84; July, 1960, 88-89; Aug. 1960, 85.
Forged Steel Flanges, E. F. Harrington, Oct. 1960, 89-95.
Mechanical Shaft Seals, Dr. S. Sussman, July, 1960, 61-66.
Piping and Plumbing, L. Blendermann, **Indirect Waste Receptor Applications,** Jan. 1960, 114-118; **Cleanouts for Underground Drainage Lines,** Feb. 1960, 99-102; **Upper Floor Cleanouts,** Mar. 1960, 92-95; **Water Accumulation Around Buildings,** April, 1960, 98-101; **Piping Sleeves,** May, 1960, 95-99; **Exterior Sand Traps,** June, 1960, 94-98; **Interior Sand and Sediment Traps,** July, 1960, 104-107; **Gasoline Station Drainage,** Aug. 1960, 100-103; **Floor Mounted Water Closet Installations,** Sept. 1960, 102-105; **Wall Mounted Water Closet Installations,** Oct. 1960, 101-104; **Floor Mounted Urinal Installations,** Nov. 1960, 100-103; **Wall Mounted Urinal Installations,** Dec. 1960, 91-94.
Recirculating Water Systems and Mechanical Pump Seals, D. B. Gardner, Dec. 1960, 57-59.
Sampling Flowing Liquid Wastes for Radioactivity Monitoring, J. M. Ruddy, Sept. 1960, 63-67.
Sprinkler Systems (Detail Sheet), Oct. 1960, 87-88.
Stainless Steel Sheathes Mechanical Service Core, Aug. 1960, 99.
Subsurface Drainage, A. Koral, May, 1960, 64-65.
Water Coil Piping (Detail Sheet), Sept. 1960, 87-88.
Wheel Load Transmitted to Pipe Under a Road (Data Sheet), Aug. 1960, 86.

PROFESSIONAL

Check Lists and Bid Form for Contractors (Data Sheet), Oct. 1960, 85-86.
Easily Drawn Graphs Show How Systems Will Work, G. W. Neal, Oct. 1960, 57-61.
Improved Engineering Practice, Dec. 1960, 95.
Single Contracts versus Separate Mechanical Contracts, May, 1960, 93-94.

PUMPS

Nomograph for Finding Pump Horsepower (Data Sheet), Nov. 1960, 88.
Mechanical Shaft Seals, Dr. Su Sussman, July, 1960, 61-66.
Pump Seals, Mechanical, Recirculating Water Systems and, D. B. Gardner, Dec.,, 1960, 57-59.

RADIOACTIVITY

Activated Carbon Filters Control Radioactive Vapors, T. T. Porembski, Nov. 1960, 97-98.
Controlling Airborne Radioactivity During "Hot" Cleanup, J. M. Ruddy, Feb. 1960, 66-69.
Optimizing Primary Coolant Piping for Nuclear Power Plants, H. Gitterman, Oct. 1960, 66-68.
Sampling Flowing Liquid Wastes for Radioactivity Monitoring, J. M. Ruddy, Sept. 1960, 63-67.

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Air Conditioning and Heating the Supermarket, W. A. Zumbiel, May, 1960, 73-80.
Air Conditioning Hospitals, I. S. Herbst, June, 1960, 75-82.
Air Conditioning System Design for Churches, Theaters and Auditoriums, J. F. Schmidt, Jan. 1960, 87-97.
Air Conditioning the Variety Store, A. Rose and S. L. Sloan, Jr., Feb. 1960, 79-87.
Air Distribution for Air Conditioning, J. W. Markert, Mar. 1960, 75-83.
Control Systems for Air Distribution in Large Buildings, J. E. Haines, Sept. 1960, 73-84.
Design and Application for Electric Heat, P. Sporn and E. R. Ambrose, July, 1960, 77-88.
Design of Pneumatic Control Centers, R. J. Caffrey, Aug. 1960, 69-75.
Display Fountains, V. Mandracchia, April, 1960, 79-86.
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Plastic Ventilation Products, H. M. Englund, Oct. 1960, 75-84.
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SOUND CONTROL

Practical Selection of Sound Control Treatment, J. W. Overend, Aug. 1960, 63-66.

STEAM HEATING

District Steam Industry Expands—Part 1, A. F. Metzger, Aug. 1960, 94-95.
Turbo-Generators Supply Steam for High Temperature Water Heating, E. G. Hansen and N. E. Pearsall, June, 1960, 90-93.

VENTILATION

Controlling Airborne Radioactivity During "Hot" Cleanup J. M. Ruddy, Feb. 1960, 66-69.
Plastic Ventilation Products (Ref. Sec.), H. M. Englund, Oct. 1960, 75-84.
Reverse-Jet Filters, K. J. Caplan, Oct. 1960, 62-65.
Three Duct Furnaces Solve Make-up Air Problems, Nov. 1960, 99.
Unit Ventilators Smooth Transition to Year-Round School Comfort, Jan. 1960, 81-82.
Volume Dampers (Detail Sheet), Dec. 1960, 84-85.
Water for Heat Pump Pre-Conditions Ventilation Air, A. W. Krause, May, 1960, 90-92.

WEATHER AND CLIMATE

All Weather Comfort Standard, May, 1960, 57-59.
Applying Weather Data to Crop Drying, C. P. Hedlin, Feb. 1960, 93-94.
Applying Weather Data to Greenhouse Cooling, C. P. Hedlin, April, 1960, 76-78.
Degree Days for 147 Cities: For Nov. 1959, Jan. 1960, 120; for Dec. 1959, Feb. 1960, 104; for Jan. 1960, Mar. 1960, 98; for Feb. 1960, April, 1960, 102; for Mar. 1960, May, 1960, 100; for April, 1960, June, 1960, 103; for May, 1960, July, 1960, 112-113; for June, 1960, Aug. 1960, 104-105; for Sept. and Oct. 1960, 99-100.
Nomograph for the Temperature-Humidity Index, H. A. Dodge, Mar. 1960, 84.
Summer-Winter Changeover — Simplified, L. H. V. Smith, Sept. 1960, 93-94.
Worldwide Summer Design Temperatures (Data Sheet), Dec. 1960, 81-82.

INDEX BY AUTHORS

Ambrose, E. R., Head, Air Conditioning Div., American Electric Power Service Corp.—Design and Application for Electric Heat (Ref. Sec.), July, 1960, 77-88.

Backer, M., and Furgiuele, G., Associates of H. E. Bovay, Jr., Consulting Engineers—Air Conditioning Operating Costs of Multi-story Office Buildings, Sept. 1960, 57-62.

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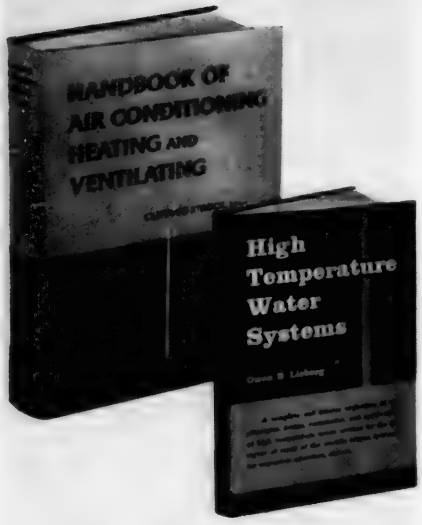

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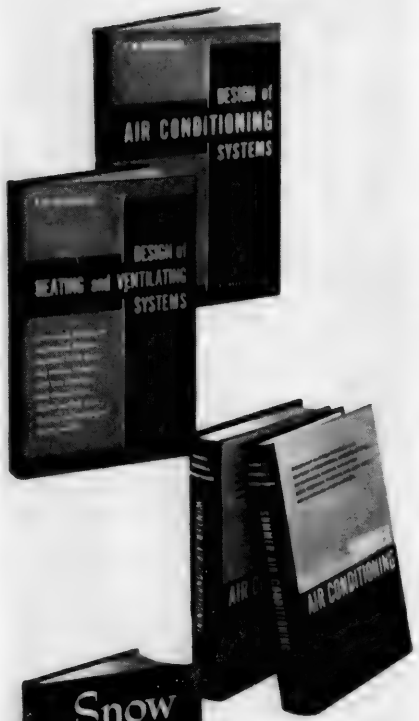

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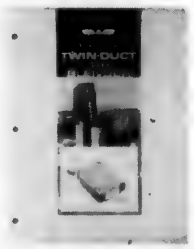

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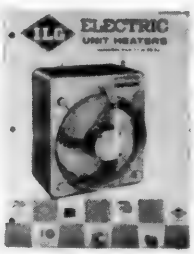
An 8-page catalog describing the operation and advantages of its twin-duct air blender, for high velocity, double duct air conditioning systems, is announced by Air Conditioning Div., Worthington Corp., East Orange, N. J. Catalog 1100-B107 includes selection and performance data.

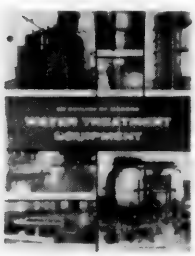
Circle **Item 2** on Inquiry Card



Electric Unit Heaters

Announced by Ilg Electric Ventilating Co., Chicago, Ill., is 4-page Bulletin 809 which contains specifications and construction details on its line of electric unit heaters, with capacities from 1.5 to 36 kw. Heaters are said to offer solutions to difficult heating problems.

Circle **Item 3** on Inquiry Card



Water Treatment Equipment

A wide range of equipment and chemicals for treatment of water for power and industrial uses is outlined in a 12-page bulletin published by The Permutit Co., div. of Pfaudler Permutit Inc., New York, N. Y. This general bulletin lists books and bulletins for specific information.

Circle **Item 4** on Inquiry Card

Making Sound Behave

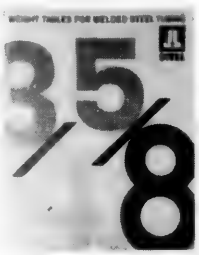
An 8-page booklet designed to accompany a sound-slide film prepared by Uni-Flo Air Distribution Div., Barber-Colman Co., Rockford, Ill., is available from the company. Important facts about air distribution sound levels are discussed in the film and in Booklet F-10180.

Circle **Item 5** on Inquiry Card

Fire Vents

Eight-page Bulletin FY-R59, available from Penn Ventilator Co., Inc., Philadelphia, Pa., is prepared to show how fire vents reduce fire destruction to commercial and industrial property. Three units are offered by the company as fire and smoke protection devices.

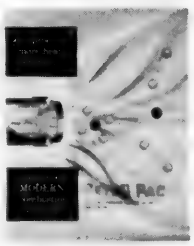
Circle **Item 6** on Inquiry Card



Welded Steel Tubing

Weight computations for welded steel tubing are easily obtained from tables in 16-page brochure prepared by Electricweld Tube Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa. Tables give dimensions and weight per foot for round mechanical, rectangular and pressure tubing.

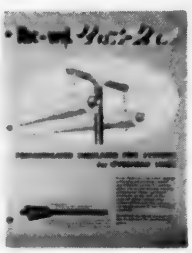
Circle **Item 7** on Inquiry Card



Sealed Firebox Generator

Four-page Form 3562 explains how the Petro Pac sealed firebox generator delivers clean, steady combustion and makes stack draft obsolete. Manufactured by Petro, Cleveland, Ohio, the packaged unit incorporates pressurized dual-fuel firing for economical steam or hot water applications.

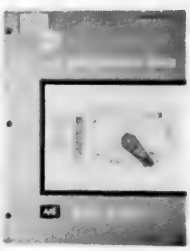
Circle **Item 8** on Inquiry Card



Overhead Piping Systems

Prefabricated insulated pipe systems, called Plasti-clad, for overhead lines are the subject of 6-page Form No. PC-11-60, published by Ric-wiL Incorporated, Barberton, Ohio. Information covers construction and accessories, expansion loop and anchor details, and support spacing.

Circle **Item 9** on Inquiry Card



Central Station Air Conditioners

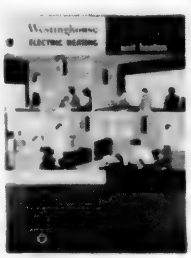
Announced by American Air Filter Co., Inc., Louisville, Ky., is Bulletin No. AC-100 describing its new line of packaged central station air conditioning units. The 60-page bulletin permits selection of unit, coils, filters and accessories without reference to separate bulletins.

Circle **Item 10** on Inquiry Card

Thermal Shock Protection

A device reported to give boilers maximum protection from thermal shock is called Therma-gard and it is manufactured by Superior Combustion Industries, Inc., New York, N. Y. An 8-page bulletin, D-2197, describes the construction and operation of this fully automatic system.

Circle **Item 11** on Inquiry Card

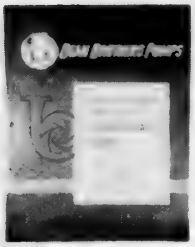


Electric Unit Heaters

Electric heating with unit heaters is the subject of 4-page Bulletin No. 27-600, published by Westinghouse Electric Corp., Staunton, Va. Featured are specifications and dimensions for heaters ranging in size from 1.5 to 36 kw. Control circuits and application data are included.

Circle **Item 12** on Inquiry Card

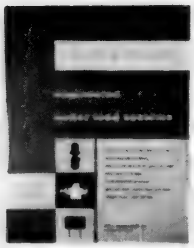
Use the prepaid yellow postcard in the back of the magazine for securing your copies of these catalogs.



Centrifugal Pumps

A 12-page selection manual for single-stage centrifugal pumps is available from Dean Brothers Pumps, Inc., Indiapanolis, Ind. Included in Circular No. 184 are recommended temperature and pressure ranges, specifications, and descriptions for ten classifications of pumps.

Circle **Item 13** on Inquiry Card



Boiler Feed Systems

Twenty-page Catalog 55-D, published by Fred H. Schaub Engineering Co., Chicago, Ill., is a quick summary and selection guide to Schaub engineered condensation drainage and automatic boiler feed systems, for industrial and heating needs. Data are arranged to simplify selection.

Circle **Item 14** on Inquiry Card

Heat Exchangers

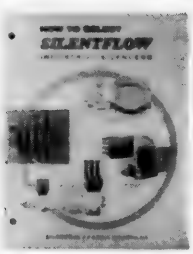
Heat exchangers from Old Dominion Iron & Steel Corp., Richmond, Va., are described in 24-page Catalog 601. It contains construction details and engineering data, including selection charts, for all types of convertors and instantaneous heaters, both steam-to-water and water-to-water.

Circle **Item 15** on Inquiry Card

Roof Exhaust Fans

A 4-page bulletin describing new PC (pleasing contour) roof exhaust fans is available from Davidson Fan Co., Newton, Mass. Bulletin No. PC-101 contains complete capacity table, dimensions and diagrams, typical specification and several photos of actual installations.

Circle **Item 16** on Inquiry Card



Industrial Silencers

How to select Silentflow industrial silencers is the theme of 4-page Bulletin B-13, published by Silence Inc., Farmingdale, N. Y. The condensed design manual details methods for evaluating and handling the problem of noise generated by gas flow devices used in industry.

Circle **Item 17** on Inquiry Card

Rotary Evaporative Cooler

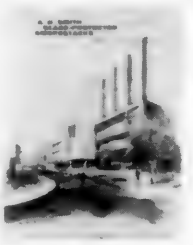
The Farr rotary evaporative cooler departs from the conventional design of evaporative coolers by employing a permanent bronze disc screen rotor which revolves continuously in a tank of water. A 4-page descriptive bulletin is available from Farr Company, Los Angeles, Calif.

Circle **Item 18** on Inquiry Card

Ductile Iron Valves

The Ohio Injector Co., Wadsworth, Ohio, announces a 12-page bulletin covering its line of gate valves designed specifically for ductile iron. Form 1011 describes the Pipe-Pal series of small (½ through 2 inch) valves, and the Pipe-Mate series of large (2 through 12 inch) valves.

Circle **Item 19** on Inquiry Card



Glass-Protected Smokestacks

An 8-page brochure describing the advantages of glass-protected smokestacks has been compiled by Atomic and Process Equipment Div., A. O. Smith Corp., Milwaukee, Wis. Comparative maintenance figures and photos of typical installations are included in Bulletin No. SS-210.

Circle **Item 20** on Inquiry Card

Incinerators

Morse Boulger, Inc., New York, N. Y., offers Bulletin No. 185 illustrating and describing the various types of incinerators which the company makes. The 8-page bulletin includes pertinent selection data for incinerators designed to serve special needs and applications.

Circle **Item 21** on Inquiry Card

Fume Hoods

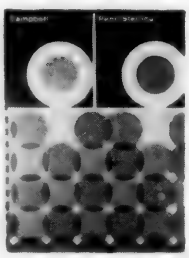
An 8-page bulletin available from Wheelabrator Corp., Mishawaka, Ind., discusses and evaluates the three accepted hooding methods for controlling fume from electric arc melting furnaces: the furnace roof type, overhead canopy hooding, and direct shell evacuation.

Circle **Item 22** on Inquiry Card

Air Density Monitor

The Detectogas air density monitor, available from Detectogas Instruments, Inc., Houston, Tex., continuously and automatically senses changes in air density due to gas infiltration. Triggering any type of alarm system, the gas detector is described in a 4-page bulletin.

Circle **Item 23** on Inquiry Card



Water Systems Equipment

A catalog describing fittings and equipment for the water systems field is published by Campbell Manufacturing Co., Boyertown, Pa., and its associate firm, Penn Sterling, Inc. It displays metal and plastic fittings for plastic pipe, well seals and caps, water hammer eliminators, and other items.

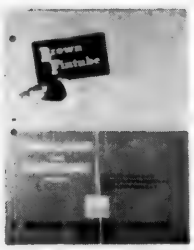
Circle **Item 24** on Inquiry Card

Use the prepaid yellow postcard in the back of the magazine for securing your copies of these catalogs.

Sliding Gate Control Valves

Eight-page Catalog J170-1 contains complete engineering information on sliding gate and plate control valves, manufactured by OPW-Jordan Corp., Cincinnati, Ohio, and recommended for steam, water, air, oil, gas and chemicals. Bulletin includes applications, sizing charts, flow curve.

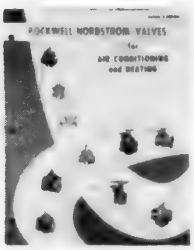
Circle **Item 25** on Inquiry Card



Double Pipe Heat Exchangers

An 8-page manual describing how to install and maintain double pipe heat exchangers is announced by Brown Fintube Co., Elyria, Ohio. Correct method of installing conventional as well as newer types of multi-tube and low pressure Brown heat exchangers is covered in Bulletin 120.

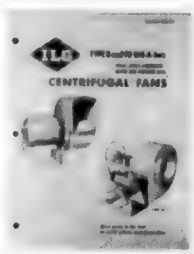
Circle **Item 26** on Inquiry Card



Lubricated Plug Valves

A 4-page bulletin describing Rockwell-Nordstrom lubricated plug valves is offered by Meter and Valve Div., Rockwell Manufacturing Co., Pittsburgh, Pa. Bulletin V-620 includes data for selecting the right balancing valves for air conditioning and heating systems.

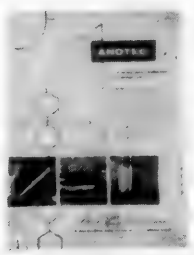
Circle **Item 27** on Inquiry Card



Small Volume Centrifugal Fans

An 8-page bulletin offering information on small volume centrifugal fans is available from Ilg Electric Ventilating Co., Chicago, Ill. Described in Bulletin DB2-306 are direct-connected, belted, and portable models. Full dimensions and specifications are included.

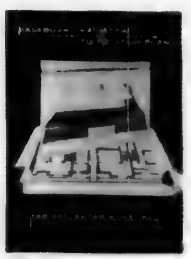
Circle **Item 28** on Inquiry Card



Architectural Grilles

Anotec anodized aluminum architectural grills are suitable for many interior and exterior applications in commercial, industrial and residential buildings. Solar screens are one example, according to an 8-page specification manual published by Klemp International, Chicago, Ill.

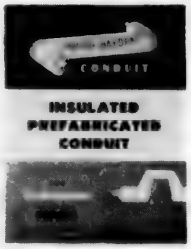
Circle **Item 29** on Inquiry Card



Hydronic Baseboard Radiation

Its complete residential line of hydronic baseboard radiation is described in a 4-page bulletin by Radiant-Ray Radiation, Inc., Newington, Conn. Advantages, rating charts, and selection data are included. Units for apartments and commercial buildings are also available.

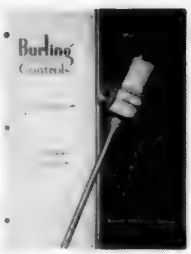
Circle **Item 30** on Inquiry Card



Insulated Prefabricated Conduit

Porter-Hayden insulated prefabricated conduit for underground and above-ground piping is the subject of 8-page Form 1160. Available from H. W. Porter & Co., Inc., Newark, N. J., it illustrates and describes construction details, and includes specifications and dimensions.

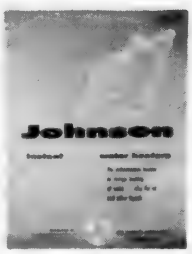
Circle **Item 31** on Inquiry Card



Temperature Controls

Four-page Catalog G-25 shows the complete line of differential expansion type temperature controls available from Burling Instrument Co., Chatham, N. J. Both electric and pneumatic instruments are covered, with description, illustration, and brief specifications for each model.

Circle **Item 32** on Inquiry Card



Instant Steam Water Heaters

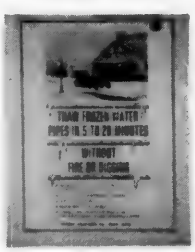
Instant steam water heaters, for use in instantaneous service or storage heating of water, oil and other liquids, are manufactured by The Johnson Corp., Three Rivers, Mich. Twelve-page Bulletin H describes these heaters and presents engineering data on their selection and application.

Circle **Item 33** on Inquiry Card

Plumbing Fixtures

Featuring "Millie the Mermaid", new corporate trademark of Milwaukee Faucets, Inc., Milwaukee, Wis., a 16-page catalog, K-6-1, describes the company's new line of concealed fixtures, Rex Adjusto shower, Mark VI submersible sump pump, and brass fixtures and accessories.

Circle **Item 34** on Inquiry Card



Thaw Frozen Pipes

Data on the fast, safe thawing of frozen water pipes with low-voltage electricity are contained in 8-page Bulletin EW-243, published by Hobart Brothers Co., Troy, Ohio. Tables show amperes and time required for thawing steel pipe, and recommended cable sizes.

Circle **Item 35** on Inquiry Card

Copper Tube Handbook

Scovill Manufacturing Co., Waterbury, Conn., offers, for your letterhead request, its 32-page Copper Tube Handbook. Designed for plumbing, heating, air conditioning and refrigeration applications, manual includes comprehensive technical and installation data, with guides to correct selection of tube and pipe.

DEGREE-DAYS FOR NOVEMBER, 1960

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city

AIR CONDITIONING, HEATING AND VENTILATING's 33rd Year of Publication of Monthly Degree-Day Data

City	November			Season to Nov. 30, incl., from Sept. 1		
	1960	1959	Normal	1960	1959	Normal
Abilene, Texas (A)	261	518	350	319	644	503
Albany, New York (A)	696	789	780	1276	1355	1362
Albuquerque, New Mexico (A)	548	628	630	807	898	858
Alpena, Michigan (C)	801	1080	864	1664	1921	1609
Anchorage, Alaska (A)	1267	1241	1281	2657	2753	2690
Asheville, North Carolina (C)	522	581	552	748	806	864
Atlanta, Georgia (A)	352	396	393	441	525	511
Atlantic City, New Jersey (C)	488	551	507	737	805	766
Augusta, Georgia (A)	313	344	282	389	419	341
Baltimore, Maryland (C)	411	539	489	603	758	725
Billings, Montana (A)	836	1023	876	1402	1817	1567
Binghamton, New York (C)	677	714	735	120-	1123	1304
Birmingham, Alabama (A)	346	427	396	445	527	532
Bismarck, North Dakota (A)	1076	1256	1098	1855	2278	1923
Block Island, Rhode Island (A)	504	585	591	892	940	1009
Boise, Idaho (A)	727	899	762	1167	1581	1286
Boston, Massachusetts (A)	503	611	618	941	1009	1010
Buffalo, New York (A)	663	784	753	1181	1283	1308
Burlington, Iowa (A)	677	968	765	1034	1474	1184
Burlington, Vermont (A)	767	889	858	1562	1591	1551
Cairo, Illinois (C)	483	660	492	626	858	681
Charleston, South Carolina (C)	149	235	214	184	263	248
Charlotte, North Carolina (A)	388	422	438	504	572	592
Chattanooga, Tennessee (A)	477	536	477	643	686	670
Cheyenne, Wyoming (A)	877	949	897	1549	1922	1715
Chicago, Illinois (A)	657	939	765	984	1407	1205
Cincinnati, Ohio (C)	486	655	567	670	926	831
Cleveland, Ohio (A)	671	769	699	1165	1195	1114
Columbia, Missouri (A)	548	824	654	772	1188	978
Columbia, South Carolina (A)	317	350	308	402	449	384
Columbus, Ohio (C)	585	737	654	878	1104	1012
Concord, New Hampshire (A)	745	788	849	1485	1447	1568
Concordia, Kansas (C)	638	833	687	879	1300	1019
Dallas, Texas (A)	237	460	299	282	533	352
Denver, Colorado (A)	759	815	771	1245	1524	1316
Des Moines, Iowa (A)	715	1034	798	1136	1636	1252
Detroit, Michigan (A)	636	845	747	1057	1345	1224
Devils Lake, North Dakota (C)	1135	1407	1197	1975	2617	2127
Dodge City, Kansas (A)	620	788	669	869	1208	669
Dubuque, Iowa (A)	806	1131	882	1345	1848	1475
Duluth, Minnesota (A)	998	1378	1092**	1904	2479	1983**
El Paso, Texas (A)	357	439	390	443	472	460
Ely, Nevada (A)	883	909	894	1594	1831	1683
Escanaba, Michigan (C)	808	1127	933	1556	1947	1735
Evansville, Indiana (A)	591	741	570	812	1035	844
Fairbanks, Alaska (A)	1975	1746	1857	3866	3650	3632
Fargo, North Dakota (A)	1046	1329	1122	1807	2301	1923
Fort Smith, Arkansas (A)	396	591	435	498	728	575
Fort Wayne, Indiana (A)	705	901	759	1123	1396	1243
Fort Worth, Texas (A)	253	470	299	298	538	357
Fresno, California (A)	394	292	345	4-0	352	431
Galveston, Texas (C)	76	253	131	91	263	131
Grand Junction, Colorado (A)	696	801	792	1051	1325	1161
Grand Rapids, Michigan (A)	688	937	822	1191	1538	1428
Green Bay, Wisconsin (A)	829	1173	945	1570	2002	1643
Greensboro, North Carolina (A)	485	534	510	688	782	741
Greenville, South Carolina (A)	367	435	411	476	605	552
Harrisburg, Pennsylvania (A)	593	683	630	923	1022	1007
Hartford, Connecticut (A)	641	697	699	1184	1170	1184
Havre, Montana (C)	1036	1136	1023	1711	2123	1857
Helena, Montana (A)	934	1219	999	1748	2222	1936
Houston, Texas (C)	111	293	162	127	303	162
Huron, South Dakota (A)	982	1203	975	1707	2047	1596
Indianapolis, Indiana	674	878	705	1018	1303	1090
Jackson, Mississippi (A)	276	410	310	347	481	379
Juneau, Alaska (A)	915	911	957	2041	2076	2153
Kansas City, Missouri (A)	555	776	621	715	1109	905
Knoxville, Tennessee (A)	482	547	498	627	704	710
La Crosse, Wisconsin (A)	798	1149	921	1384	1882	1520
Lander, Wyoming (A)	1030	1120	1050	1743	2064	1926
Lewiston, Maine (O)	750	781	876	1493	147	1542

a) Data not available.
* Figures based on Airport readings.
** Figures based on City office readings.

Normal figures in this table are based on 30-year period covering 1921 to 1950, inclusive, as compiled and published by the U. S. Weather Bureau.

Figures in this table, with two exceptions, based on local weather bureau reports. Exceptions are Utica and Lewiston, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Co., Utica, N. Y., and Norman E. Ross, Bursar, Bates College, Lewiston, Me., respectively.

Degree-Days for November, 1960 (Concluded)

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city

AIR CONDITIONING, HEATING AND VENTILATING'S 33rd Year of Publication of Monthly Degree-Day Data

City	November			Season to Nov. 30, incl., from Sept. 1		
	1960	1959	Normal	1960	1959	Normal
Lincoln, Nebraska (C)	690	908	741	1011	1431	1130
Little Rock, Arkansas (A)	431	543	405	534	649	525
Los Angeles, California (C)	135	23	140	157	25	198
Louisville, Kentucky (A)	596	642	579	846	894	862
Lynchburg, Virginia (A)	492	577	531	747	864	816
Macon, Georgia (A)	273	317	280	340	396	343
Madison, Wisconsin (A)	816	1129	864	1434	1832	1420
Marquette, Michigan (C)	833	1161	933	1585	2035	1712
Memphis, Tennessee (A)	425	547	432	529	658	575
Meridian, Mississippi (A)	313	402	338	394	483	428
Milwaukee, Wisconsin (A)	766	1059	831	1402	1705	1393
Minneapolis, Minnesota (A)	943	1181	960	1648	1967	1576
Moline, Illinois (A)	700	1002	786	1106	1564	1245
Montgomery, Alabama	289	332	304	353	393	373
Nashville, Tennessee (A)	509	587	471	657	757	647
New Haven, Connecticut (A)	588	638	663	1041	1022	1119
New Orleans, Louisiana (C)	69	235	141	86	248	146
New York, New York (C)	476	595	561	750	879	863
Newark, New Jersey (A)	485	578	603	846	850	951
Norfolk, Virginia (A)	368	424	408	507	567	569
North Platte, Nebraska (A)	844	1034	846	1357	1826	1391
Oak Ridge, Tennessee (C)	528	527	550	697	680	775
Oakland, California (A)	340	272	336	555	359	569
Oklahoma City, Oklahoma (A)	407	640	459	505	870	620
Omaha, Nebraska (A)	704	948	783	1049	1496	1202
Parkersburg, West Virginia (C)	546	676	600	816	995	928
Peoria, Illinois (A)	724	956	759	1119	1441	1184
Philadelphia, Pennsylvania (C)	430	551	516	639	786	768
Phoenix, Arizona (A)	153	119	182	169	145	195
Pittsburgh, Pennsylvania (C)	540	661	612	842	1002	966
Pittsfield, Massachusetts (A)	716	834	843	1445	1494	1599
Pocatello, Idaho (A)	(a)	(a)	873	(a)	(a)	1543
Portland, Maine (A)	723	786	825	1509	1489	1539
Portland, Oregon (C)	497	554	534	830	902	899
Providence, Rhode Island (A)	573	644	672	1072	1099	1160
Pueblo, Colorado (A)	679	785	771	1050	1396	1228
Raleigh, North Carolina (A)	422	473	387	603	685	515
Rapid City, South Dakota (A)	837	1107	891	1398	1997	1584
Reading, Pennsylvania (C)	540	633	588	849	926	930
Red Bluff, California (A)	377	233	319	430	277	378
Reno, Nevada (A)	747	737	744	1367	1385	1352
Richmond, Virginia (A)	439	530	498	720	783	741
Rochester, New York (A)	647	806	759	1182	1339	1332
Roswell, New Mexico (A)	507	593	501	695	798	665
Sacramento, Cailfornia (C)	369	309	321	424	369	413
St. Joseph, Missouri (A)	634	860	600	918	1317	882
St. Louis, Missouri (C)	503	745	570	701	995	810
Salt Lake City, Utah (A)	730	814	771	1166	1406	1240
San Antonio, Texas (A)	138	374	201	155	401	226
San Diego, California (A)	129	23	147	154	34	223
Sandusky, Ohio (C)	608	795	684	959	1215	1077
San Francisco, California (C)	276	146	237	586	292	475
Sault Ste. Marie, Michigan (A)	854	1160	1005	1726	2077	1942
Savannah, Georgia (A)	183	261	225	227	291	263
Scranton, Pennsylvania (A)	700	810	693	1238	1276	1197
Seattle, Washington (C)	536	541	540	980	1036	1003
Sheridan, Wyoming (A)	936	1152	957	1647	2086	1774
Shreveport, Louisiana (A)	251	462	305	292	523	358
Sioux City, Iowa (A)	769	1084	885	1201	1742	1418
Spokane, Washington (A)	886	997	879	1542	1889	1592
Springfield, Illinois (A)	639	861	666	915	1256	981
Springfield, Missouri (A)	539	774	615	731	1106	925
Syracuse, New York (A)	630	786	714	1173	1294	1227
Toledo, Ohio (A)	716	899	756	1174	1467	1245
Topeka, Kansas (C)	609	838	630	856	1276	914
Trenton, New Jersey (C)	504	598	582	820	900	922
Tulsa, Oklahoma (A)	393	614	462	481	798	632
Utica, New York (O)	548	749	781	985	1173	1393
Valentine, Nebraska (A)	860	1146	891	1461	2034	1497
Walla Walla, Washington (C)	624	770	675	957	1217	1076
Washington, D. C. (A)	489	545	510**	708	791	773**
Wichita, Kansas (A)	545	748	597	729	1089	848
Williston, North Dakota (C)	1070	1249	1101	1811	2349	1967
Winnemucca, Nevada (A)	795	868	822	1422	1613	1510
Yakima, Washington (A)	799	889	807	1375	1542	1403

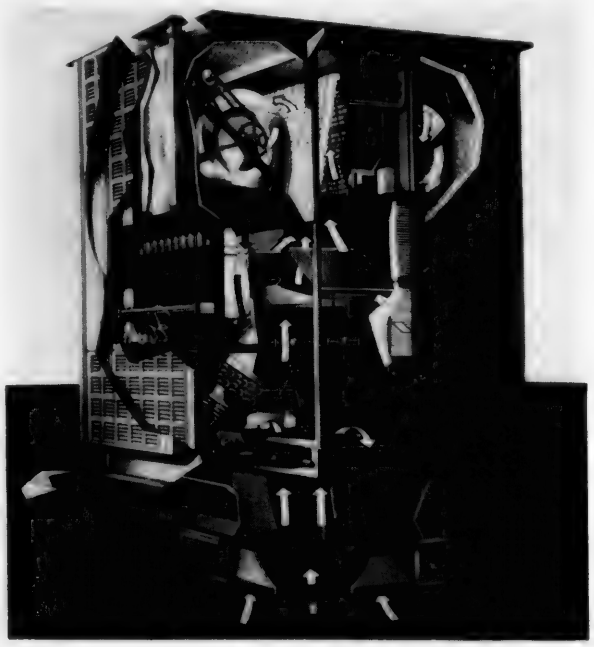
For footnotes, see page 100.

NEWS OF EQUIPMENT AND MATERIALS

Use the convenient prepaid yellow postcard in the back of the magazine for securing more information about new equipment and materials described in this department.

Roof Top Unit

A roof top unit is available from Lennox Industries, Inc., Marshalltown, Iowa, that combines two of the company's Landmark units into one flexible package. Delivering either 7½ or 10 tons of cooling, the unit puts out 163,000 to 272,000 Btuh of heating, all controlled by a single heating-cooling thermostat or, at the owner's option, by two thermostats each controlling a separate zone. Automatically controlled outside air, up to 100%, is available for ventilation and for cooling.



Components of the unit include a transition piece which fits into the roof opening; a diffuser head which includes a 36 x 6 inch Lima 4-way deflection series HV register on each of four sides, allowing air to be deflected downward toward doorways from one side and thrown straight out, so as not to interfere, for instance, with meat cases in a supermarket; a base frame of Z-bar construction to fit into the roof and accept the damper filter section and Landmark units; a damper filter section; two Landmark down-flo heating and cooling units; and a weather-proof cabinet.

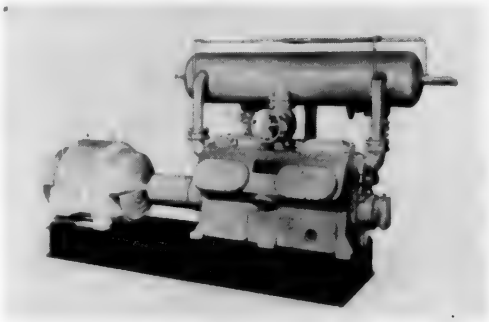
The roof top units can be used in multiples, providing an extremely flexible system that will serve many different kinds and combinations of space: supermarkets, partitioned office areas, etc. The company offers a detailed kit with complete data on the unit and its applications.

More Information? Circle Item 36 on Inquiry Card.

Two-Stage, 12-Cylinder Compressor

The Vilter Manufacturing Co., Milwaukee, Wis., has broadened its line of two-stage VMC compressors with the introduction of a 12-cylinder model to supplement its previously-introduced 6-cylinder unit.

With these two units, a range from 6 through 40 tons of refrigeration is possible depending upon operating conditions. Offered for direct-connected or V-belt



drive, two-stage compressors can be supplied for operation with ammonia, Refrigerant 12 and 22.

Called ideal for a variety of applications, the two-stage VMC is especially suited for use where a processing function requires low temperature refrigeration and costs or floor limitations prevent selection of individual booster and high-stage compressors.

More Information? Circle Item 37 on Inquiry Card.

Shock Absorber for Apartments

A new shock absorber designed to eliminate water hammer occurring in the supply lines of residences and apartments is available from Josam Mfg. Co., Michigan City, Ind. The low-in-cost "Genie" is easily installed and carries a 10-year guarantee.

Unit operates on a principle similar to the company's commercial-type shock absorbers. Inside an Absorbo tube expands to absorb the water hammer shocks and vibrations which cause trouble in supply lines to washing machines, showers, dishwashers and other household equipment.

Molded of strong Dupont Delrin thermoplastic, and with a displacement of 4 cubic inches, the shell is impervious to exterior corrosion from most chemicals and 180 deg F hot water.

More Information? Circle Item 38 on Inquiry Card.

Compact Centrifugal Pumps

A new series of centrifugal Motorpumps runs very quietly because of the 1750 rpm operating speed, according to the manufacturer, Ingersoll-Rand Co., Phillipsburg, N.J. Pumps are particularly suited for air conditioning and heating installations, and other applications where low noise level may be important. The

units, called 1750K-Line Motorpumps, are designed for eye appeal and compactness. Pumping rates range from 15 to 500 gallons per minute, with heads to 110 feet. Ball bearing motors are from ¾ to 7½ horsepower, and are available in drip-proof or totally-enclosed construction. Units have smooth lines because all bolting for casing and motor is on the supporting head.

Versatility is extended by the variety of positions in which pump can be mounted. In addition, the casing can be rotated and set to direct the pump discharge in any of four directions, eliminating pipe joints and angles which would increase friction and impede free flow of liquid.

Both impeller and shaft sleeve are integral parts of a single casting. The shaft seal is a spring-loaded mechanical seal designed for dripless operation and minimum power consumption.

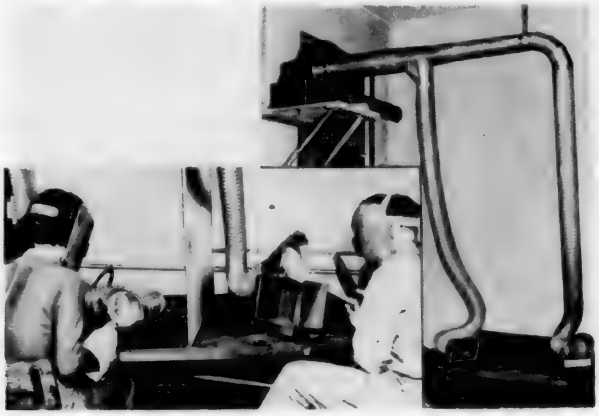
More Information? Circle Item 39 on Inquiry Card.

Dual Table-Type Exhauster

A simple and economical dual table installation for welding shops, said to clean air safely in any layout, is announced by Car-Mon Products, Inc., Chicago, Ill. The carbon monoxide ventilating system not only removes poisonous fumes, but, by saving 80% of the heat lost through conventional ventilation to eliminate fumes, also reduces fuel bills and keeps premises comfortable, the company states.

Called the Dual Tab-L-Exhauster, unit assures "on-the-spot" efficiency with powerful suction in magnet-base receptor intakes. A lifetime-magnet base holds the receptor intake securely right on the work, or on any nearby metal. Fumes are drawn off before they come to the weldor's breathing line. Long, flexible weldproof tubing is said to permit fast, easy positioning of the receptor in a wide work range.

A single fan draws off all gases, smoke, heat and fumes from both receptors. Induction-type ¾ hp

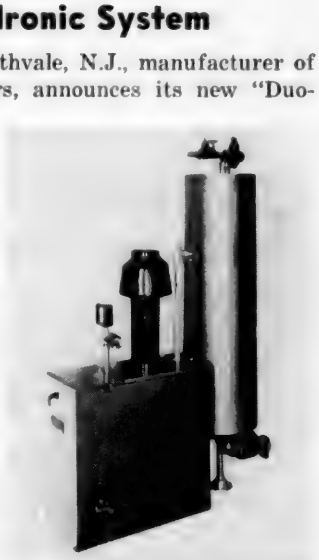


motor (single or 3-phase) has permanently sealed ball bearings. Unit includes heavy steel platform and supports; isolators; streamlined steel tapered airflow tubing and fan discharger tube; weldproof flexible hose and magnetic receptors.

More Information? Circle Item 40 on Inquiry Card.

Two-Service Hydronic System

Hydrotherm, Inc., Northvale, N.J., manufacturer of gas-fired hydronic boilers, announces its new "Duo-Service" system, designed to supply heat and domestic hot water with much smaller boiler sizes than previously possible.



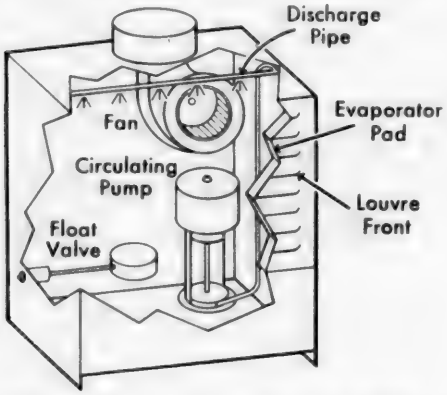
By placing a heat exchanger coil in the expansion tank rather than in the boiler itself, large heat storage and improved heat transfer are effected, the company reports. This makes it possible to specify boiler capacity on the basis of heating loads only, providing better heating performance and reduced fuel costs. Domestic hot water is assured with boiler input ratings as low at 50,000 Btu per hr, as opposed to 125,000 Btu per hr ratings required by boilers with conventional built-in coils.

The system is completely factory engineered and packaged. In addition to a Hydrotherm boiler, it comprises the vertical Hydro-Tank, flow control valve, pressure reducing (fill) valve, flow limiting valve, circulator, thermostat, and relay.

More Information? Circle Item 41 on Inquiry Card.

Provides Salt-Free Humidity

Powermatic Model 333 humidifier, added to the Miss-T-Aire line of humidifiers manufactured by H. G. Stocker & Son, Inc., Osceola, Wis., provides a permanent out-of-the-way installation for homes, offices, or buildings with hot water, steam, gravity warm air, and larger forced air systems, the company states. The



new model joins previously marketed Models 101 and 102 for forced warm air heated homes for delivering calcium-dust free humidity.

Unit can be ceiling hung or stand-supported. Kit includes precision humidistat. Water supply is controlled through automatic float valve. Pump circulates water over evaporator pad. High-volume fan gives rapid discharge of moisture laden air through building.

More Information? Circle Item 42 on Inquiry Card.

Pipe Dope in Tape Form

Pipe-Pac, a new pipe dope in tape form, is available from Johns-Manville Corp., New York, N. Y. The material is reported to have numerous advantages in many plumbing operations involving threaded joints in all types of pipe. According to J-M, it offers a fast, economical method of getting clean, tight, permanent pipe couplings in metal, plastic, ceramic, rubber, and other pipe materials.

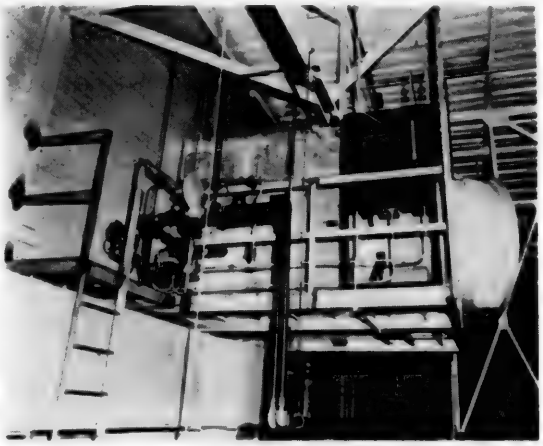
Recommended for pipe carrying water, steam, oil, gas, air, and corrosive chemicals of all types, in services from minus 300 to plus 500 deg F, Pipe-Pac will prevent "freezing" of the joint, allowing easy disassembly if needed for maintenance. In addition, the tape will not cake or harden, and is clean and easy to handle. It will not soften and run when the pipe is put into service, the company states.

More Information? Circle Item 43 on Inquiry Card.

Packaged Air Make-up Units

Seven packaged air make-up units for supplying 20,000 to 80,000 cfm are offered by J. O. Ross Engineering Div., Midland-Ross Corp., New York, N. Y.

Each unit comprises a galvanized sheet-metal en-



closure, approximately 7 ft high x 7 ft wide x 8 ft long. One end fits an outside wall opening and is equipped with intake louvers, bird screens, and shutdown dampers. The other is equipped with a fan which draws the air from out-of-doors and directs it into the plant.

A rectangular gas burner inside the enclosure heats incoming winter air to 80 F prior to distribution into the plant. Enclosure has 3-inch thick insulation all around to eliminate wintertime condensation.

Shown in the accompanying photograph is a standard 60,000 cfm gas-heated air make-up unit installed near the ceiling of a bleachery. Unit is one of four supplying make-up air to this department.

More Information? Circle Item 44 on Inquiry Card.

Low-Temperature Insulation

United States Mineral Wool Co., Stanhope, N. J., announces the manufacture of Cellofoam low-temperature insulation, a closed cell, rigid, expanded polystyrene product.

Available in both regular and self-extinguishing forms, insulation is manufactured to a maximum length of 12 ft 4 inches, widths of 12, 16 and 24 inches, and a thickness range of ½ through 8 inches. Tested at a mean temperature of 40 deg F, Cellofoam provided a thermal conductivity *(k)* value of 0.22 and possesses inherently low water absorption and moisture permeability characteristics.

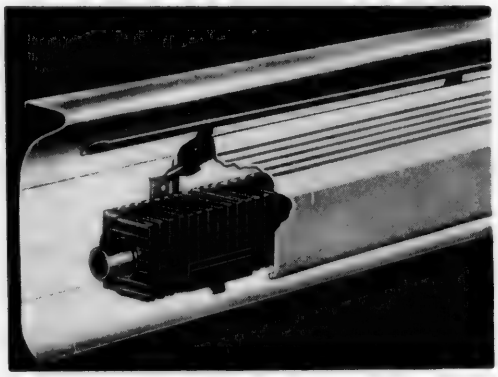
Manufactured at a density of 1.0-2.0 lb per cu ft, insulation possesses high bond strength for finishing applications and excellent resistance to impact and compression loads, the company states. The product may be applied to masonry, wood, concrete and steel surfaces in applications subject to operating temperatures as low as minus 60 deg.

More Information? Circle Item 45 on Inquiry Card.

Improved Cradle Slide

Edwards Engineering Corp., Pompton Plains, N.J., announces the development of an improved cradle slide for use with its baseboard heating elements.

The new slide permits free longitudinal movement



of the baseboard element during periods of heating expansion and cooling contraction, and is designed to eliminate metallic noises.

Installation has also been simplified, the company reports. The new cradle slide snaps into place on all Edwards baseboard units. On company's packaged heating elements, the slide is furnished already in position and ready for use.

More Information? Circle Item 46 on Inquiry Card.

Movable Exhaust System

A movable exhaust system, called Swing-O-Way, is announced by Ammerman Co., Inc., Stillwater, Minn., and is called ideal for use where traveling overhead cranes will not permit ductwork to be suspended from the ceiling of large repair shops, such as heavy high-

way construction equipment, diesel truck and tractor repair, welding or soldering.

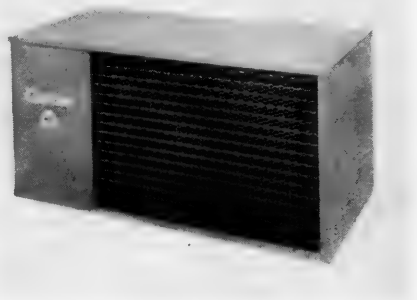
The wall or post mountings permit 180-degree swing range. The retractable flexible hose allows for an extension up to 30 ft from the blower. System, which boasts heavy, rigid construction with a powerful, high speed motor, is shipped completely assembled.

More Information? Circle Item 47 on Inquiry Card.

Small Condensing Units

Carrier Air Conditioning Co., Syracuse, N. Y., has started producing a line of air-cooled condensing units designed around its new Micromite compressor.

Available in models of 2, 2½ and 3 tons capacity, the units will cost significantly less to purchase and operate than the models they replace, it is reported.



The cost reductions are made possible by the Micromite compressor, a compact, welded steel hermetic unit which the company recently put into production.

Sound level has been reduced by improved acoustic insulation and the use of a larger, low speed condensing fan. A patented electrical control circuit eliminates rapid cycling of the compressor and manual resetting, and insures longer life for electrical components. Controls are not affected by heat from the sun, and are dustproof.

More Information? Circle Item 48 on Inquiry Card.

Schoolroom Ventilator

A counter-flow Inn-a-Wal heating and ventilating unit is added to the line of schoolroom systems manufactured by Norman Products Co., Columbus, Ohio. It is designed for installation where the code requires a separate heater room with fire resistant walls, or in a free standing installation in the corner of a classroom. Automatically controlled dampers mix outdoor and indoor air.

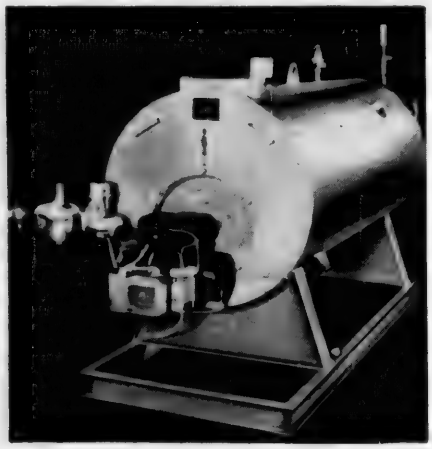
The entire classroom distribution system is through Util-i-Duct bookshelf sections which are installed around the outside perimeter of the classroom under windows. Adjustable filler sections to flush in with wall partitions, and corner sections, are available. A perimeter air diffuser along the top of each bookshelf section has an adjustable damper for balanced air distribution.

System is a gas-fired, forced-air installation, approved by AGA as a counter flow forced air furnace for use against static pressures up to 50 inches of water, and for use with temperature rises of 70 to 105 deg F. Models are available from 80,000 to 100,000 Btu per hr.

More Information? Circle Item 49 on Inquiry Card.

Hot Water Generators

A heating unit and boiler in a combination package is introduced by Atlantic Steel Boiler Co., Philadelphia, Pa. For laundromats, small laundries, automatic car washes, hotels and motels, restaurants, and any establishment requiring a large volume of hot water,



the combined automatic hot water generators come equipped for burning either oil, gas, or a combination of the two.

Among its advantages, the company says, are reduced installation costs over separately installed hot water generating units, plus the elimination of large and high chimneys since boiler needs only a small exhaust outlet for its burner for which higher combustion efficiencies are claimed.

The complete boiler units include a forced draft burner and controls mounted and wired, water mixing valve installed, unit ready for connection to water and electric services. Boiler design, fiberglass insulation, and location of boiler tubes, are said to result in very rapid recovery: 10 to 12 min. from cold start to 212 deg F. Seven sizes are available to handle a peak recovery rate of 550 to 2100 gph.

Maximum height of the largest unit is only 58 inches, making boilers easy to install in places of low headroom, and they come mounted on steel channels enabling simple installation or location change. Make-up water due to evaporation is seldom needed, as the unit operates as a closed hot water system maintaining an operating temperature of 230 deg.

More Information? Circle Item 50 on Inquiry Card.

Polypropylene Piping Fittings

Production of a limited size range of polypropylene plastic fittings for industrial piping is announced by Tube Turns Plastics Inc., Louisville, Ky. The new line is being stocked initially in 2- and 4-inch pipe sizes and in Schedules 40 and 80 wall thickness and can be extended readily to cover a complete size range.

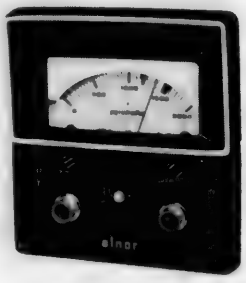
Use of polypropylene pipe and fittings has been enhanced by recent perfection of Thermo-Seal homogeneous fusing that has eliminated past difficulties in joining. Chief applications are in petroleum and natural gas production for low-pressure ambient-temperature applications such as gathering lines and salt water disposal systems. Market studies are being conducted of potential uses of the corrosion-resistant material in gas distribution lines and industrial piping systems.

The newest polypropylene polymers appear to be considerably more rugged than more familiar polyolefins that have been available longer, the company states.

More Information? Circle Item 51 on Inquiry Card.

Temperature Indicating Controller

A double-target temperature indicating-controlling pyrometer, the N-15 Pyrotroller, is introduced by Alnor Instrument Co., Chicago, Ill.



The accurate, electronic on-off controller provides a second control point for secondary or additional action. For instance, besides controlling temperature, the N-15 Pyrotroller also could independently open and close a valve, or turn a motor or blower on and off.

The attractive, modern instrument case of die-cast aluminum, with black enamel finish and satin trim, is designed for flush mounting. Only 6⅜ x 7 inches, it makes a highly desirable panel board instrument, the company reports.

Controller is available in eleven ranges from 0-400 deg F to 0-3000 deg, as well as in an environmental test chamber range of −100 to +300 deg.

More Information? Circle Item 52 on Inquiry Card.

Piping Drawing Instrument

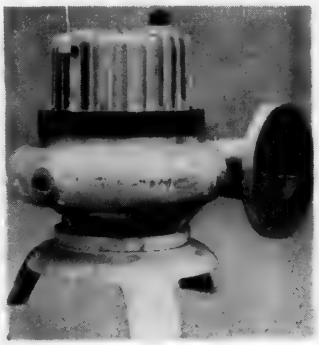
A template designed for isometric pipe drawings has been developed by Wally Verrett, a graduate engineer, Port Arthur, Tex. This simple tool enables standardized isometric drawings to be made of all pipe layout sketches, he reports.

Because of its simplicity, even beginners are said to be able to make professional drawings the first time. Features include: pocket size, cut-outs for most common fitting symbols, laminated clear plastic, rounded corners for uniform angles, and handy compass orientation points. Engineers, operators, pipe sketchers, detailers, draftsmen and designers would find this tool a very welcome addition to their drawing boards, he states.

More Information? Circle Item 53 on Inquiry Card.

Non-Clog Submersible Pumps

Non-clog submersible pumps newly announced by Fairbanks, Morse & Co., Chicago, Ill., are especially designed to handle large solids and stringy materials, such as industrial material or wastes, raw or treated sewage, light sludge and slurries.



These compact all-in-one pump and motor units are equipped with a one-piece cast iron impeller either in two-blade design or, where excessive clogging would otherwise be encountered, in the company's bladeless impeller design. The pumps come in 2-inch, 3-inch and 4-inch sizes.

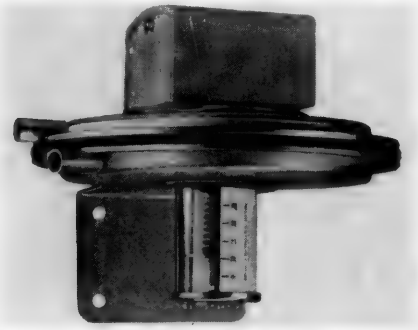
The totally enclosed non-ventilated induction motor, available in a range from ¾ to 7½ hp, has an oil-filled interior and finned exterior for rapid cooling in underwater operation. The one-piece motor and pump shaft is stainless steel (316) for resistance to corrosion.

Installation in any sump or pit requires only one piping connection and a plug-in electrical connection. Typical applications of this pump include storm water drainage, small sewage lift stations and general purpose sump drainage.

More Information? Circle Item 54 on Inquiry Card.

Differential Pressure Switch

A differential pressure switch, made by F. W. Dwyer Mfg. Co., Michigan City, Ind., is designed for extremely accurate and reliable control in pressure ranges too low for conventional switches. Dead band is unusually small. One model of this Series 1630 differential pressure switch, for example, may be set



to open a circuit on a pressure differential increase of only 0.05 inch of water and to close on a decrease of 0.03 inch. With repetitive accuracy within 1%, there is virtually no error due to drift or hysteresis, the company states.

Switch is suitable for applications to liquid level controls, induced draft interlocks, exhaust hoods, dust collection systems and air filters. Specific examples include: low air velocity detection, control of air curtain systems, counting devices, and monitoring of pressurized rooms or areas.

More Information? Circle Item 55 on Inquiry Card.

Plastic Air Ducting

Fabrication of a new form of air ducting, called Ventilating Tubing, is announced by B.E.P. Industrial Equipment, Detroit, Mich. This flexible ducting is made from Fabron polyvinyl chloride, said to be lightweight, tough, extremely hard wearing, economical, air-proof, waterproof, unaffected by damp; a material that will not rot or corrode under the most adverse underground conditions. In addition, Fabron does not support combustion and is self-extinguishing.

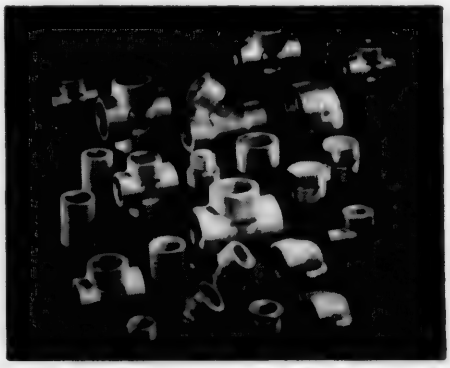
Tubing was developed in cooperation with several mines to provide adequate ventilation through miles of underground tunnels, the company states. Diameters range from 10 to 30 inches in 12, 16, and 20-ounce weights. Manufactured in 75-ft lengths, tubing is provided with supporting bands 2 inches wide into which a brass grommet is fitted. No elbows or joints are needed.

More Information? Circle Item 56 on Inquiry Card.

High-Pressure Pipe Fittings

A line of high-pressure pipe fittings, featuring a Parkerized rust-proof finish, is announced by Clayton Mark & Company, Evanston, Ill.

Line includes a complete selection of forged steel screw and socket welding fittings to meet 2000, 3000,



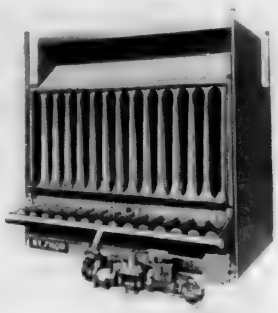
4000, and 6000-lb pressure specifications. Included are 45 and 90 degree elbows, tees, cross and lateral fittings, couplings, reducers, and caps to fit pipe sizes from ⅛ to 4 inches.

The Parkerized finish imparts a phosphate coating to steel, protecting the exterior and interior against rust scale even when fittings are stored or used under highly humid conditions, according to the company.

More Information? Circle Item 57 on Inquiry Card.

Downstream Installation Approved

The American Gas Association has given its approval to Reznor Manufacturing Co., Mercer, Pa., for downstream installation of the company's DS Series modular duct furnaces in year-around packaged air conditioning systems.



Such AGA approval requires:

1. Use of corrosion resistant materials in heat exchangers, carryover parts, and pilots.
2. Provision for proper elimination of condensate.

Downstream installation of duct furnaces is reported to benefit the installer and user because of easier maintenance and the comparative simplicity of such installations, eliminating the necessity of installing special by-pass duct work to isolate the furnace when it is not in operation during summer months. In addition, such installation allows re-heating in circumstances where the tempered air first must be chilled for removal of moisture.

The DS Series duct furnaces are available in capacities from 150,000 to 300,000 Btu and may be installed singly or in multiples for greater heating requirements.

More Information? Circle Item 58 on Inquiry Card.

Bronze Ball Valve

Fig. BL-300 forged naval bronze ball valve, introduced by R-P&C Valve Div., American Chain & Cable Co., Inc., Reading, Pa., is rated at 300 lb for water, oil or gas service at a maximum temperature of 250 deg F in sizes ½ to 2 inches inclusive. Valve has undergone hundreds of thousands of openings and closings without sign of leakage or wear, the company states.

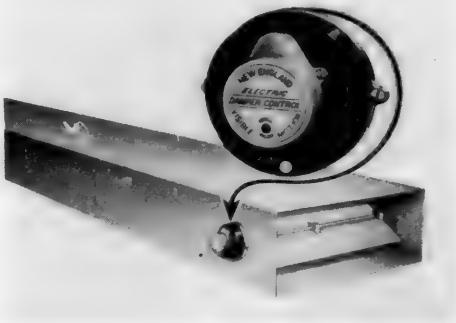
Fast and easy to operate, since it requires only a quick quarter turn of the handle to open or close compared to several full turns needed to operate a gate or globe valve, the ball valve is a precision-built valve for general purpose service at a cost no more than a high quality standard bronze gate valve, the company states.

According to the manufacturer, ball valves have "arrived" as one of our basic valve types. In hundreds of applications which heretofore have gone uncontested to some of our standard valve types, the ball valve is now commanding more and more attention as original or replacement equipment. Ball valves have passed from a research or experimental phase into a practical service phase which has verified their design superiority for certain kinds of straight-way flow service.

More Information? Circle Item 59 on Inquiry Card.

Electric Damper Control

Described as powerful, small and compact, electric damper controls made by New England Gear Works, Inc., Southington, Conn., are called ideal for individual room thermostatic control of heating and cooling installations. Use of the units is said to assure



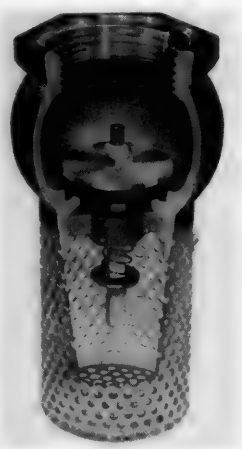
proper distribution of heating or cooling to only those rooms requiring it, providing automatic compensation for open doors and windows, wind shifts, crowds and fire places, all of which affect room temperatures. Control is easy to install, easy to wire, and easy to adjust.

Available for round ducts are completely assembled duct sets, with damper control, damper vane and position indicator already mounted on short sections of 4, 5, and 6-inch round duct.

More Information? Circle Item 60 on Inquiry Card.

Bronze Foot Valve

No. 123 bronze spring-loaded foot valve, offered by Typhoon Products, Coral Gables, Fla., boasts above-average performance:



Spherical styling of body is said to allow a greater volume of water flow. Square stem allows fine sand and mineral deposits to pass through, but edges of the stem act as frictional cleaners.

Brass seat is used as an O-ring against a flat neoprene surface, affording positive seal under all conditions, the company states. Phosphor naval bronze spring in very resistant to most waters and oil chemicals. Heavy-gage, perforated brass sheet strainer and perforated strainer bottom allow a greater volume of water to pass through, especially where the valve is retained in a well casing.

More Information? Circle Item 61 on Inquiry Card.

(Continued on page 110)

SPORLAN

G VALVES...

the No. 1 choice for Refrigerated Cases,

utilize

SPORLAN SELECTIVE CHARGES...

famous since 1934

SPORLAN "C" CHARGE
for Suction Temperatures Above ZERO

SPORLAN "Z" CHARGE
for Suction Temperatures Below ZERO

SPORLAN "X" CHARGE
for Extremely Low Temperatures

More engineering features are incorporated in the Sporlan G valve than in any other valve... yet the basic design has always been sound... and has never been changed.

Modifications will always be made, but only to improve the valve... never to change it.

for PEAK PERFORMANCE... on all refrigeration applications, send for new bulletin 10-10 today ...then order your G valves from your friendly Sporlan Wholesaler.

SPORLAN VALVE COMPANY

7525 SUSSEX AVENUE ST. LOUIS 17, MISSOURI

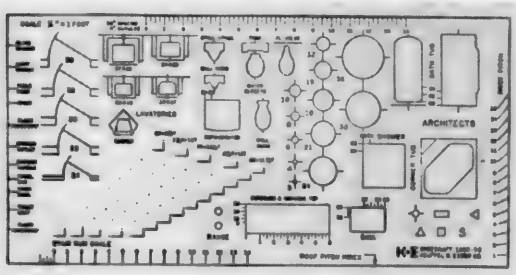
EXPORT DEPT. 85 BROAD STREET NEW YORK 4, N. Y.

(Continued from page 108)

Drafting Template

A versatile drafting template for making architectural drawings is included in a line of templates offered by Keuffel & Esser Co., Hoboken, N. J. Trade-named Speedraft, the line consists of eighteen individual templates for a variety of applications.

An architectural drawing template contains a com-



pact arrangement of the most widely used symbols for bathroom-kitchen fixtures and equipment, electrical outlets and door swings. It also provides a handy stair-run scale for various rises and treads, and a roof pitch scale.

Templates for use in drawings of office plans, store layouts, electrical and electronic diagrams, and plans for ductwork; and templates for drawing circles, squares, triangles, ellipses and other drawing symbols, all in graduated sizes and scales, are included in the new line.

More Information? Circle Item 62 on Inquiry Card.

Aluminum Pipe Flanges

Forged aluminum pipe flanges, companion products to its line of aluminum butt-weld fittings, are produced by Flowline Corp., New Castle, Pa.

Flanges, made in ½ through 24-inch pipe sizes of aluminum alloys 3003-F and 6061-T6, are stocked in all popular sizes. They are made to conform to A.S.A. B16.5 150-lb and 300-lb steel flange standards, and are available in these types: welding neck, slip-on, lap-joint, threaded, and blind.

More Information? Circle Item 63 on Inquiry Card.

Heavy-Duty Water Softeners

Permutit Water Conditioning Inc., a division of Pfaudler Permutit Inc., New York, N. Y., has introduced for institutional, commercial and domesitc use a series of low-price heavy-duty water softeners that have had extensive proving in industry.

Known as Model BD, these units are now available for use in a wide range of businesses, residential units and institutions, including motels, small hospitals, schools, stores, apartments, self-service laundries, beauty and barber shops, restaurants, and cafeterias. Water softeners have found wide acceptance in all these installations, but it has been found that increasing demands for soft water have made larger-capacity softeners desirable. Formerly, in some installations of this type, it has been necessary to make multiple-unit hookups of lower-capacity residential type water softeners to meet demands.

The Model BD is produced in four basic sizes ranging from 300,000 to 1,380,000 grains capacity and from 40 to 100 gallons per minute output. The softeners are easily installed from pre-packaged assemblies and all operate with high-capacity Permutit Q Resin.

More Information? Circle Item 64 on Inquiry Card.

Plastic Jointed Clay Pipe

Available from American Vitrified Products Co., Cleveland, Ohio, is Amvit plastic jointed vitrified clay pipe in sizes 4 inches through 24 inches with all standard fittings. While over 100,000 miles of it have already been laid, it is now available in longer lengths.

Joint is manufactured from plasticized resins of polyvinyl chloride. No special tools are needed during installation, and the line can be laid in the most severe weather, the company states.

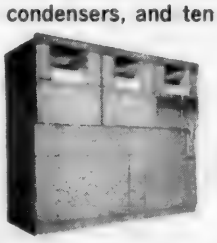
Design of the joint is based on the ball and socket principle. Material on the spigot end is a convex shape, with the bell end in a concave shape. This permits easy and rapid installation. When the joint is made, it reaches maximum compression, said to result in a really tight line. Design of joint assures self centering which gives a smoother invert. Due to tightness of joint, no foreign matter can get in.

More Information? Circle Item 65 on Inquiry Card.

(Continued on page 112)

which man specified Typhoon ?

That complacent looking fellow on top of the pole. He knows Typhoon will deliver beyond specifications—guaranteeing satisfaction. With the addition of 28 new units to its 1961 Line, Typhoon offers the industry's broadest, biggest, most versatile group of packaged air conditioners, furnaces and heat pumps. Typhoon economy begins with its mass produced components, which can be custom-assembled to your order to meet any unusual requirement...**at little or no extra cost.** Typhoon quality begins with Power Reserve—superior components and oversize parts to deliver beyond rated capacities. Each Typhoon unit is built to take extreme weather conditions and sudden severe temperature changes without strain or breakdown. The 28 new units include nine heat pumps, three air handlers, three air cooled remote condensing units, three air cooled condensers, and ten self-contained package units. **For complete satisfaction,** specify Typhoon. It suits every need in air or water cooled units; ceiling, floor or roof mounted units; units that heat and cool or cool only — in capacities from 3 to 75 tons. Write us for complete product literature.



Water Cooled Self-Contained Packaged Units 3 to 75 Tons

TYPHOON

HUPP

TYPHOON AIR CONDITIONING DIVISION, HUPP CORPORATION
505 Carroll Street, Brooklyn 15, New York 2-1-1

☐ Please send me full product literature on Typhoon's 1961 Line.
☐ Please have a representative call for an appointment.

NAME_____

FIRM_____

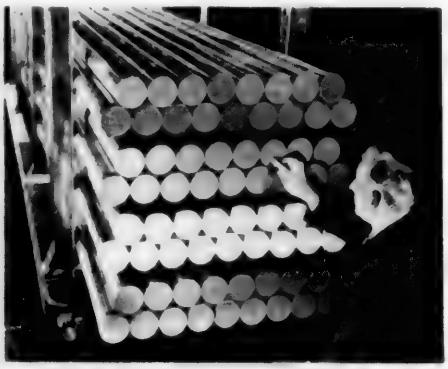
ADDRESS_____

CITY_____ ZONE_____ STATE____

(Continued from page 110)

Tube Protection, Identification

A new program to provide complete protection and ready identification of plumbing and heating copper tube is announced by Chase Brass & Copper Co., a subsidiary of Kennecott Copper Corp., Waterbury, Conn.



Color-coded plastic caps are now being used to cover the ends of selected sizes of straight lengths of copper water tube for heating and plumbing lines. The caps make it easy for the heating and plumbing contractor to immediately identify tube size and type on the job site. Also, they provide maximum protection to tube interiors and are simple to remove than the wooden plugs used previously.

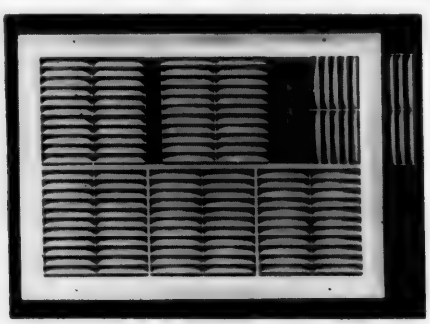
In addition, types are identified by a coyored stripe extending the length of the tube. The new plastic caps will facilitate the keeping of inventories by plumbing wholesalers, the company reports.

More Information? Circle Item 66 on Inquiry Card.

Modular Return Air Grilles

Added to its line of all-nylon registers, grilles and diffusers, AirGuide Plastics Corp., Miami, Fla., announces production of its Convert-it return air grilles based on a modular concept.

Unbreakable, non-corrosive, non-combustible square module sections are injection molded in one piece with



vanes set at 30° angle, allowing total free area of approximately 75% based on core area. In grilles larger than 6 inches square, modules are mounted in aluminum mullion channels, permitting build-up in 6-inch increments, in sizes up to 36 x 24 inches. Entire assembly is contained in an extruded aluminum frame assuring rigidity in large sizes.

Wholesaler, in stocking any specific size, can have inventory flexibility of two sizes, in each grille. By sliding the modules out of the channels, they may be turned in the opposite direction and re-inserted.

More Information? Circle Item 67 on Inquiry Card.

Ends Waterlogged Tanks

A simple, compact air charger, said to be trouble-free, is attached to the discharge of pumps by Dorward Pump Div., Besler Corp., Emeryville, Oakland,

Calif. The unit is a venturi built into the brass control valve plug.

At the start of each pumping cycle, a gulp of air is sucked in through a snifter valve and discharged into the pressure tank. According to the company, users report that this single device consistently prevents troublesome tank waterlogging and accordingly prolongs motor life.

More Information? Circle Item 68 on Inquiry Card.

Electronic Flame-Out System

Split-second electronic detection of flame-out and immediate shut-down of industrial and commercial combustion facilities is achieved with a simplified combustion programming system for medium to large installations of 300,000 Btu and up, announces General Controls Co., Glendale, Calif.

If a flame-out should occur, for example, in a central heating plant, enough gas or oil to constitute a hazard might accumulate during the reaction time of slower devices, according to the manufacturer. However, with this electronic programming system, detection of flame-out would occur instantly and shut-down could be expected in as little as one-half second. A midget ultraviolet detector tube sees and reacts almost instantaneously to the presence or absence of flame only.

More Information? Circle Item 69 on Inquiry Card.

(Continued on page 115)

Marsh Presents

A Superior Adjustable Orifice Valve

Easy to do!

The stop screw in the sectional view below provides the orifice adjustment. Simply close the valve, remove the handle-screw and insert screwdriver in the open stem to engage slot in stop screw. Turn the stop screw as far down as it will go. Then back it off to the required orifice opening.

In a steam system, back stop screw one turn for each 10 sq. ft. of direct radiation. In a hot water system, as many turns as indicated by flow requirements of system, either precalculated or checked by devices for determining flow.

Note that valve is non-rising stem type and can only be opened to position permitted by stop screw setting. Provision is made for sealing the adjustment tamper-proof after setting orifice.

Here is the answer to easy, highly efficient balancing of both steam and hot water systems... a radiator valve in which you can accurately adjust orifice opening with the twist of a screwdriver; without shutting down the system; without breaking the union connection.

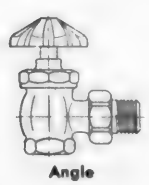
A stop screw in the valve stem, as illustrated here, enables you to set the modulating cone for any required flow: on steam, from 10 to 100 sq. ft. E.D.R.; on hot water, to any indicated flow at any given pressure.

Read opposite how simply and effectively the flow is adjusted. Once the opening is set, the special taper of the modulating cone assures the correct flow of steam or water through the orifice at any opening. In other words, the flow curve through the valve at *any* given pressure is a *straight line* throughout the full range of valve opening. Since the adjustment only limits the amount of opening, shut-off is positive at any adjustment without disrupting orifice setting.

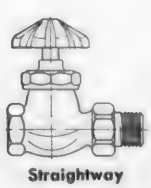
A new valve with time-tried Marsh design

This feature is all the more significant because it is found in a valve that incorporates the truly packless, metal-to-metal seal construction so highly respected in the Marsh R-100 series and now brought to still higher standards.

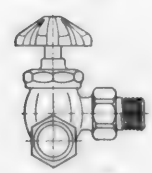
The new adjustable R-105 series is available in ½", ¾" and 1" sizes; angle, straightway, and corner patterns. Ask for special bulletin.



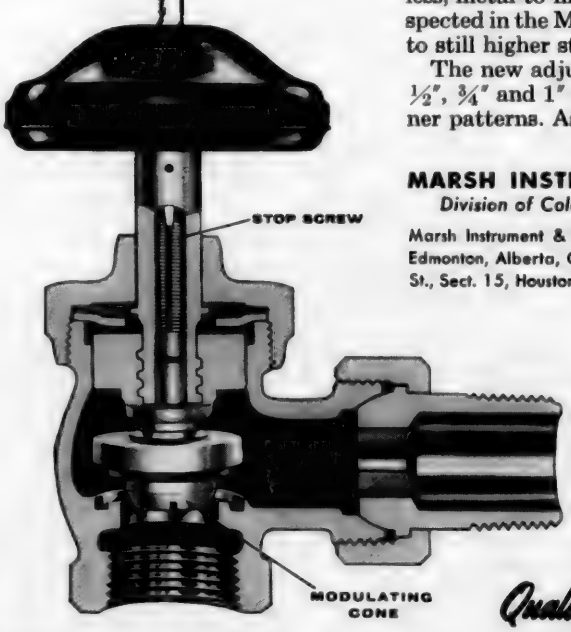
Angle



Straightway



Corner—either right or left hand



MARSH INSTRUMENT CO., Skokie, Illinois
Division of Colorado Oil & Gas Corporation, Dept. U

Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada; Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.

MARSH

Quality Heating Specialties since 1865

New LENNOX Roof Top Unit

...a new concept in zoned heating, ventilating and air conditioning...

Now, out of sight, out of mind, out of high cost rental area! This new Lennox Roof Top Unit sits quietly on the roof, overseeing the comfort conditions required by your business. Consisting of two Lennox Landmark (modular heating and cooling) units, it is handsomely cased and expertly designed into one flexible package. It's available in 7½ and 10 tons of cooling, controlled by one heating/cooling thermostat; or it can be split into two zones, each controlled by a separate heating/cooling thermostat. Gas heating capacities range from 204,000 (in increments of 34,000) up to 340,000 Btuh. Automatically controlled outside air (up to 100%) is available for ventilation and "free" cooling.

"WRAP AROUND" FILTER BANK
... easy to change, low replacement cost—sized for low velocity, long life.

LARGE CAPACITY BLOWER
... moves air at low sound levels—vertical design of unit means air is turned only 180°—horizontal units must turn air 360°.

WEATHER-PROOF CABINET
... made of galvanized steel with acrylic finish for long, rust-free life. Pleasingly neutral, dawn-grey color.

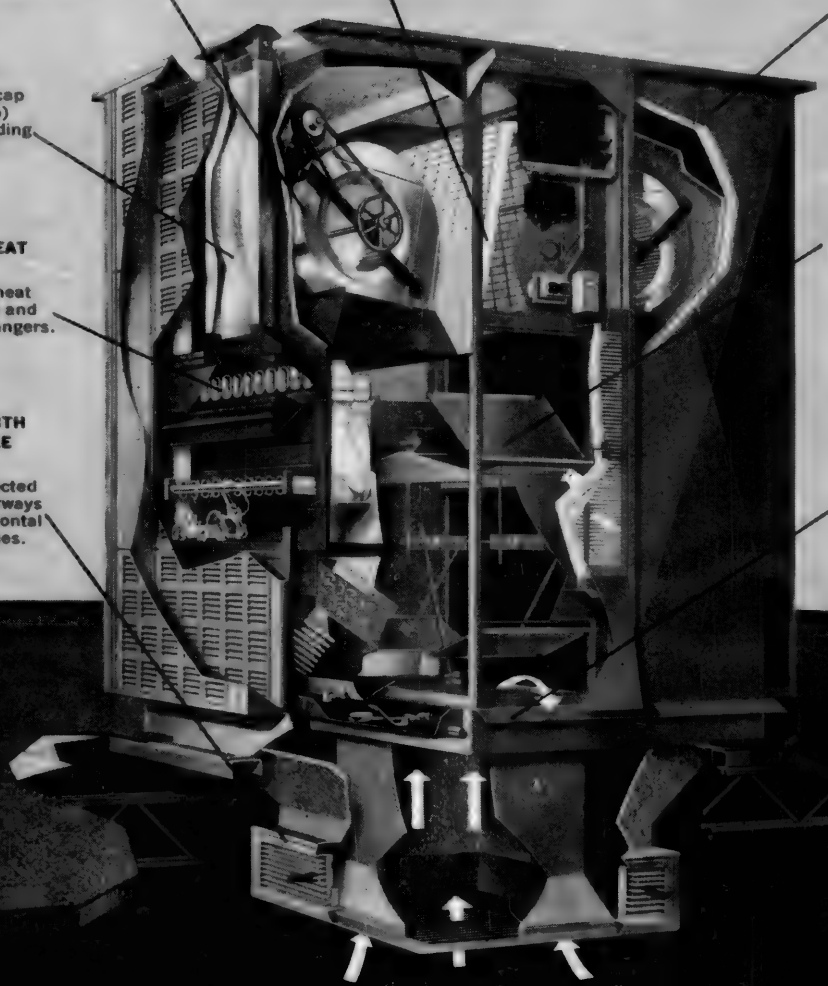
INTERNAL FLUE RISE
... requires just a 3" rain cap (extending above the top) making the total unit, including flue, only 89" above the sub-floor of the roof.

AUTOMATIC DAMPERS
... pre-wired, pre-adjusted—operated by a modulating damper motor controlled by a mixed air temperature sensing bulb. Controls both outside and exhaust air.

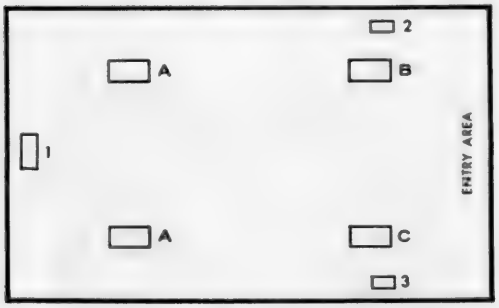
ALUMINIZED STEEL HEAT EXCHANGERS
... provide exceptional heat transfer—built to out-last and out-perform ordinary exchangers.

DIFFUSER HEADS WITH 4-WAY ADJUSTABLE LOUVERS
... allow air to be deflected downward toward doorways from one side and horizontal on the other three sides.

BASE FRAME
... Z bar construction—only 224" of flashing is required around roof opening—all easily accessible.

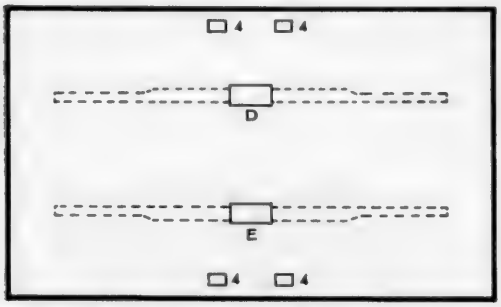


...completely automatic—including outside and exhaust air control



Unmatched installation flexibility for large open areas

Units "A" are for rear zone of building. Each has two cooling and heating sections . . . a total of 408,000 Btuh heating and 18 tons of cooling. Condensing unit (1) serves both "A" units. Unit "B" has one 170,000 Btuh heat section discharging toward door (which can be thermostatically controlled for entryway heating), and one 136,000 Btuh section discharging away from door, with combination heating–cooling thermostat. Condensing unit (2) serves both cooling sections. Unit "C" has two 136,000 Btuh heating sections, and two cooling sections with a total of 7½ tons cooling, served by condensing unit (3).



Ideal for partitioned office areas

Here the Lennox Roof Top Units are connected to ducts. Unit "D" serves two zones with 136,000 and 102,000 Btuh heating, with 5 tons of cooling each. Unit "E" serves two zones with 136,000 and 170,000 Btuh heating, with 4 and 5 tons cooling. Units marked (4) are the individual air cooled condensing units.

WRITE FOR COMPLETE DATA, OFFERED FREE IN DETAILED "ROOF TOP UNIT" KIT. ADDRESS: LENNOX INDUSTRIES INC., 612 S. 12TH AVENUE, MARSHALLTOWN, IOWA.

Don't be satisfied with less than

LENNOX

HEATING · AIR CONDITIONING

IN HOMES IN CHURCHES IN SCHOOLS IN BUSINESS IN INDUSTRY

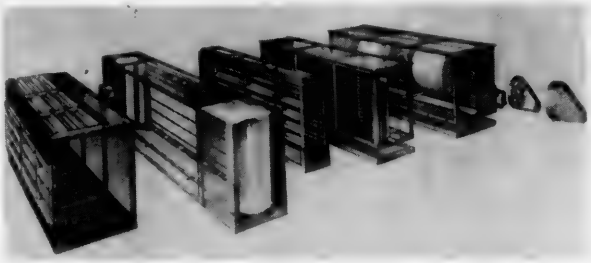
LENNOX INDUSTRIES INC., FOUNDED 1895 — MARSHALLTOWN AND DES MOINES, IOWA; COLUMBUS, OHIO; SYRACUSE, NEW YORK; DECATUR, GEORGIA; FT. WORTH, TEXAS; SALT LAKE CITY, UTAH; LOS ANGELES, CALIFORNIA. LENNOX INDUSTRIES (CANADA) LTD.—TORONTO, MONTREAL, CALGARY, VANCOUVER, WINNIPEG

Circle this page number on card back of book

(Continued from page 112)

Central Station Air Conditioners

An entirely new line of packaged central station air conditioning units is introduced by American Air Filter Co., Inc., Louisville, Ky. These Kennard/Nelson units offer a complete central station package where all components, including fans, coils, humidifiers, dampers, filters, frame and casing are designed, fabri-



cated and tested by one manufacturer.

For the first time, the company reports, both unit and automatic air filters are available in a complete selection as pre-selected and matched components of an air conditioning unit. The new units are not only engineered to meet exacting conditions of air quantities, temperatures and humidities, but also to provide any degree of air cleaning—all in one package.

The line is available in both horizontal and vertical models in 14 basic sizes, with 24 different arrangements per size—500 cfm to 36,000 cfm. Both forwardly curved and backwardly inclined centrifugal fans are offered against static pressures up to 9.0 inches.

More Information? Circle Item 70 on Inquiry Card.

Industrial Motors

The Lima Electric Motor Co., Inc., Lima, Ohio, offers a wide line of industrial motors in the new NEMA frame sizes. Features include pre-lubricated, double-width, sealed ball bearings; dual fans for double-end ventilation, integrally cast with rotor; dynamically balanced rotor assemblies; rigid, cast iron frames with integrally cast feet; mylar insulation; higher full-load speeds; roomy connection boxes; and totally enclosed frames.

Included in the line are Type RS dripproof motors from ½ to 150 hp; Type E totally enclosed fan cooled motors from ½ to 75 hp; Type EX explosion proof motors from ½ to 30 hp; and Type EFD totally encloser fan duty motors (air over motor) from ½ to 15 hp. Also included are many special application motors, in horizontal and vertical models, gear reducers, gearmotors, shaft mounted reducers, gearshift drives, and straight line reducers.

More Information? Circle Item 71 on Inquiry Card.

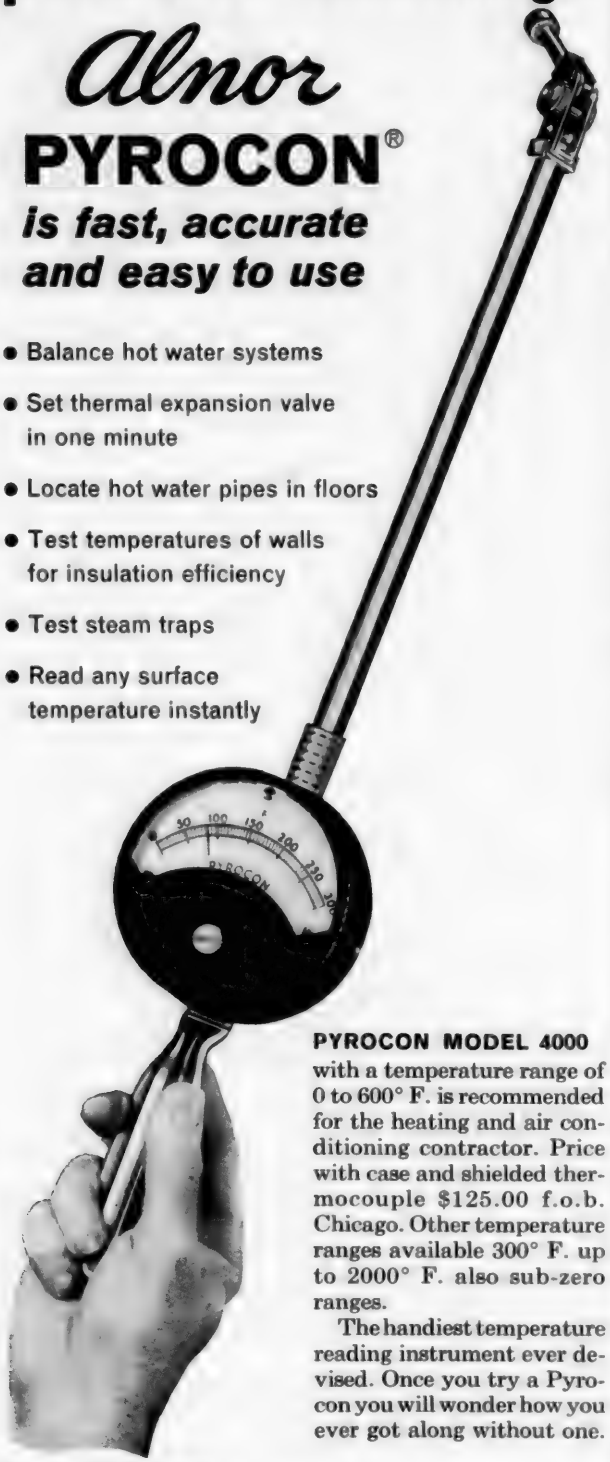
For Surface Temperature Readings

Alnor

PYROCON®

is fast, accurate and easy to use

- Balance hot water systems
- Set thermal expansion valve in one minute
- Locate hot water pipes in floors
- Test temperatures of walls for insulation efficiency
- Test steam traps
- Read any surface temperature instantly



PYROCON MODEL 4000 with a temperature range of 0 to 600° F. is recommended for the heating and air conditioning contractor. Price with case and shielded thermocouple $125.00 f.o.b. Chicago. Other temperature ranges available 300° F. up to 2000° F. also sub-zero ranges.

The handiest temperature reading instrument ever devised. Once you try a Pyrocon you will wonder how you ever got along without one.

Alnor INSTRUMENTS

ALNOR INSTRUMENT CO.

Division of

Illinois Testing Laboratories, Inc.

Room 570, 420 N. La Salle St., Chicago 10, Ill.

Circle this page number on card back of book

Aluminum Lavatory

Addition of Model A-75 lavatory to its Super Secur Ware line of unbreakable cast aluminum plumbing fixtures is announced by Aluminum Plumbing Fixture Corp., Burlingame, Calif. Its design is the customary

one associated with ordinary vitreous china fixtures.

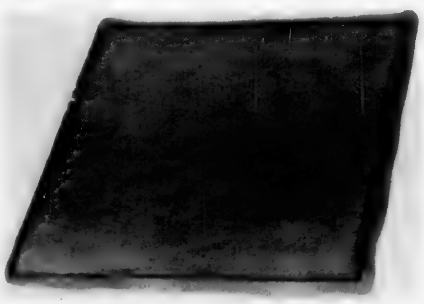
Lavatory is wall hung, but legs can be attached. Compact 18 x 20-inch size and virtual indestructibility make these lavatories well suited for institutional use, the company states.

More Information? Circle Item 72 on Inquiry Card.

Long-Lived Panel Filter

Up to 50% longer service life, increased dust-holding capacity, and ease of installation are claimed for ULOK disposable Flat Filter announced by Union Carbide Development Co., Div. of Union Carbide Corp., New York, N. Y.

Filter is made of Dynel, a strong fiber with a highly-



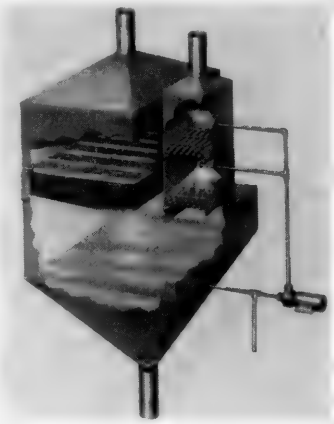
irregular cross-section that stops and holds unusually large quantities of dust and is resistant to oils and adhesives, the company states. This media provides a low density, three-dimensional batt, the entire face and depth of which trap dirt particles, as the inherent strength of the media permits the elimination of face supports and the batt construction permits depth loading.

Ring support permits filter to seal itself in holding frame as well as to extend beyond the edge of the ring, insuring a compression fit around all edges. This is said to eliminate the problem of filter bypass. With no retainers to stop air flow, face of each filter is completely exposed, providing up to 30% more filtering area per unit.

More Information? Circle Item 73 on Inquiry Card.

Low-Power Coal Dust Collector

An air scrubbing system said to provide an economical solution to the dust collecting problems of industrial plants is marketed as L-S Air Scrubber by Antipol Corp., Galesburg, Ill. Unit utilizes a water spray over stainless steel screening to entrap impurities. Discharged air may be recirculated in the plant or released to the atmosphere without risk of contamination, the company states.

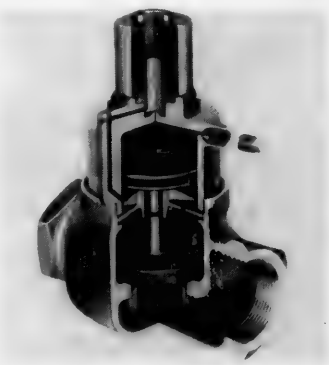


According to the manufacturer, with no moving parts the scrubber is easily maintained. Pressure drop of the air entering the system is low, thus reducing power requirements. The self-cleaning design permits constant operation. Dust recovery in typical applications is as high as 99%, water consumption as little as 1 gpm per 1,000 cfm of air. Units available up to 50,000 cfm.

More Information? Circle Item 74 on Inquiry Card.

Remote Control Valves

For automatic opening, closing and timing of pipe lines, remote control valves introduced by Febco, Incorporated, Los Angeles, Calif., are used in conjunction with a simple cam switch, timing switch or sequence timer.



Applications include water conditioning systems, coolant systems, filtration plants, swimming pools, water works piping, lawn sprinkler systems, gym showers, cooling towers, laundries, altitude valves, and food, pharmaceutical and chemical processes. Valves are rated for 150-psi water at 150 deg F. and are available for 1-6 inch pipe.

Model 1825 valves incorporate a solenoid and are connected by wiring to the timing device. Model 25 valves are hydraulically actuated through plastic or copper tubing which links them with a hydraulic controller. Both types close automatically in event of electrical or hydraulic power failure.

More Information? Circle Item 75 on Inquiry Card.

First in the industry to be approved by AMCA and first in their class to be tested and rated as they are most commonly used, Aerovent Belt-Driven Vaneaxial Fans permit you to select exactly the unit you need without the necessity for recalculating performances to accommodate belt and drive losses. And, they are rated without accessory transformations, which means that performances are even more attractive when entrance orifices or tapered cones are required.

Furnished in sizes 12" to 60" for capacities to 74,860 CFM, each unit also carries Aerovent's own Certified Performance label—your guarantee that our equipment will perform as represented.

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Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

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Aerovent Fans

Aerovent

FAN COMPANY, INC.

ASH AND BRANDT STS. PIQUA, OHIO

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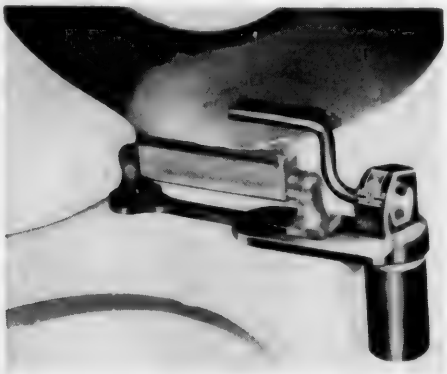
Toilet Seat Control

Announced by Tym Controls, West Terre Haute, Ind., is the Tym seat control, a hydraulic attachment for industrial-type toilet seats. By its use a commode installation becomes primarily a urinal installation. Designed for women's rest rooms, it is also recommended for men's rest rooms having an insufficient number of urinals.



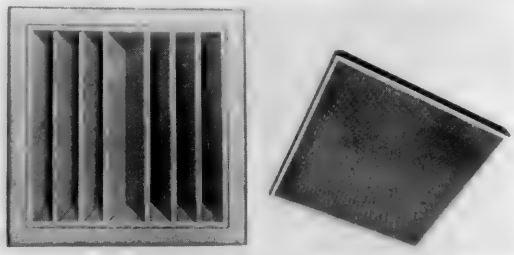
The device has hydraulic action similar to that of the hydraulic door check. Delayed action in the horizontal position provides time for the adjustment of a seat cover. When released, the seat automatically raises.

More Information? Circle Item 76 on Inquiry Card.

Two Ceiling Air Diffusers

Two ceiling diffusers have been added to its Kno-Draft line by Connor Engineering Corp., Danbury, Conn.

Available in both square and rectangular designs, the



Type KO perforated unit offers simple styling that blends with the rectilinear lines of interior architectural schemes and integrates neatly with acoustical ceiling tiles.

Type KSS diffuser offers a variety of air pattern arrangements to satisfy different application and installation requirements. The 1,2,3,4-way blow KSS is available in square or rectangular configurations, and in a range of sizes—a combination which permits use of various types of ceiling mountings.

More Information? Circle Item 77 on Inquiry Card.

ADV.

AN ANNOUNCEMENT

To Our Friends in the Heating Industry

Effective the first of this year, our operations are established at Carpentersville, Illinois. This is the same location as ILLINOIS IRON & BOLT COMPANY, the major supplier of the modern coal-burning equipment we distribute.

We feel this move will streamline our business operations to allow us to offer you even better service than we have in the past. In this new year, and at this new location, we look forward to working with you to serve the heating and power needs of the nation.

Please change your records to show:

BITUMINOUS COAL EQUIPMENT, Inc.

Carpentersville, Illinois

New Pediatric Bath

A new pediatric bath, designed specifically for hospital use, is introduced by American-Standard Plumbing and Heating Div., New York, N. Y. The appearance of this wall-hung china tub marks an important addition to the hospital pediatric department because it eliminates the adaptation of conventional fixtures for young children.

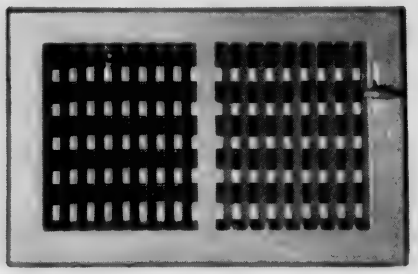
The bath can be mounted at counter height so that nurses can handle bathing chores without bending strain. A shelf can be easily constructed on the side of the tub to provide a drying area at a comfortable level for the attendant.

A bell supply fitting, which fits almost flush on the back of the tub, is used for the fill, and the tub is furnished complete with overflow and pop-up drain. A thermostatic control supply valve is installed on the wall above the fixture and out of reach of the child.

More Information? Circle Item 78 on Inquiry Card.

Sidewall Registers

Series 10V shallow-valve sidewall registers, featuring a multi-louver damper, is announced by Lima Register Co., Lima, Ohio. Units are available in four sizes, covering installation requirements from 8 x 6 to 14 x 6



inches, and are ideal for low-budget combination heating-cooling systems, the company said.

Face vanes are set at 45°, ½ inch apart, for wide-spreading, two-way vertical deflection. Multi-louvers assure precise upward and downward throw, controlled by positive-action lever. Shallow-valve design simplifies installation on any conventional stackhead. Welded construction permits full control of high velocity air without whistle or rattle.

More Information? Circle Item 79 on Inquiry Card.

Airsan Viro Crimp
HIGH VELOCITY AIR FILTERS

has special Hemmed Edges for strength and safe, easy handling. No Cuts! No Scratches! No Filter surface damage.

VIRO CRIMP MEDIA

MAXIMUM EFFICIENCY AT (300 — 600 FPM)
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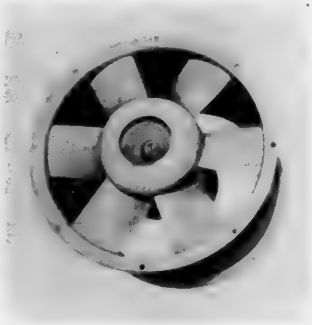
Axial-Flow Fans

A new line of direct-driven and belt-driven axial flow fans for general ventilation, dust and fume removal, and similar services is announced by L. J. Wing Mfg. Co., Linden, N.J.



Designs are based upon the heavy-duty units the company has for many years furnished for Navy and Merchant Marine use.

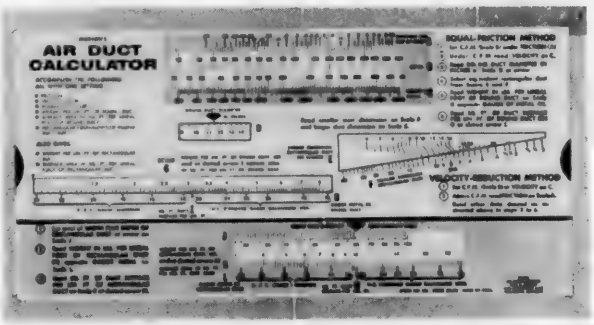
Fans are available in direct-driven and belt-driven vaneaxial types, and direct-driven tubeaxial types for use where air-straightening vanes are not required. Capacities at zero static pressure range from 3220 to 72,500 cfm.

Features of these fans include airfoil fan wheels; flanged, heavy-gage fan casings; sealed, pre-lubricated, self-aligning bearings; and improved capacity per horsepower. A complete choice of motor types is available, and options include aluminum fan wheels, anti-corrosion materials and protective coatings, inlet and outlet cones, and adjustable sheaves.

More Information? Circle Item 80 on Inquiry Card.

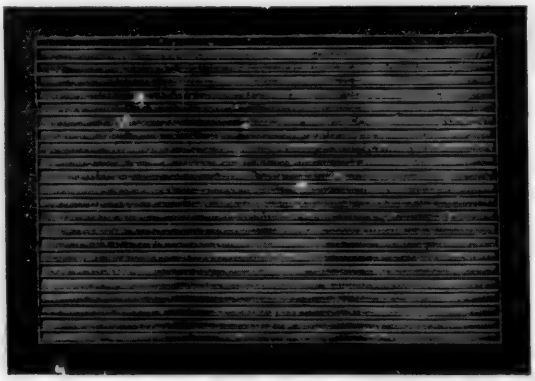
Air Duct Calculator

Called completely new, a pocket-size air duct calculator having but a single slide is announced by Paul S. Morton Engineering Service, 5131 Meadowlark Lane, Kalamazoo, Mich.

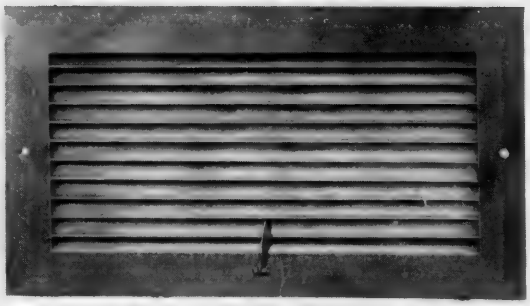


With the calculator, duct sizing by the equal-friction or velocity-reduction method, in addition to estimating metal and insulation requirements, is much simplified. Most data will be quickly found with but a single setting of the slide. On the back of the calculator is tabulated useful data abstracted with permission from the 1959 Heating, Ventilating and Air Conditioning Guide.

The actual size of the calculator is 4 by 8½ inches, and its cost is two and one-half dollars.



No. A-760-B All Alumium, No-Vision Grille

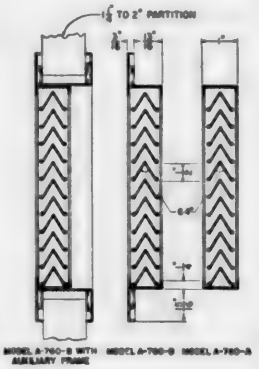


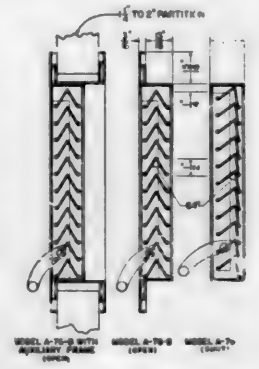
No. A-76-B All Aluminum, Shut-Off Type, No-Vision Grille

A-J NO-VISION ALL ALUMINUM GRILLES

Fixed and Shut-Off Types

ALL NEW! The A-J No. A-760 and A-76 Series no-vision grilles, being only 13/16" thick, have no bulky depth to extend beyond door thickness. Excellent for duct installation for supply and return air. Louvers are on ½" centers, and are completely sightproof from any angle. Free area is approximately 48%. Corrosion and rust-proof. Requires no upkeep. Satin finish is standard.





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REGISTERS

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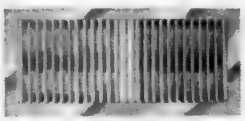

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For more data circle item 121A

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U.L. APPROVED **PRESSURE BURNERS**

DUAL-FUEL GAS OIL
The Prestige Burner

Designed for the hard-to-fire jobs. Fires all types of boilers, warm air furnaces, and ovens. Standard features are "extras" on other burners. Flame retention . . . controlled flame pattern . . . rotary action flame . . . automatic fuel-air ratio . . . latest electronic safety control . . . polished aluminum housing. Factory wired and fire-tested.

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A SPUN END CHECK VALVE AND STRAINER COMBINATION

U.S. PAT. NO. 2,646,071

Magni-Chek is a non-electric magnetically operated check valve, so finely calibrated that a fraction of an ounce of pressure will open the passage permitting a smooth flow without the usual pressure drop. Since no springs are used back pressure is at a minimum.

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- Built-in Monel Strainer
- Lifetime Alnico Magnet
- Maximum Flow
- Minimum Back Pressure
- Not Affected By Soldering Heat

This valve is also available without the strainer, and both types are stocked in the following sizes: 1/4", 5/16", 3/8", 1/2", 5/8" and 3/4". Special size inlet and outlet connections can be made to your specifications.

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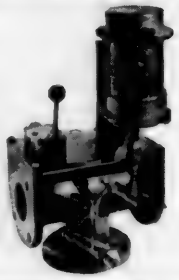
IT SAVES MONEY



The all-new Triangle Valve by U. S. Valve & Engineering Co. is a combination of TWO precision-engineered butterfly valves in a flanged T. It gives perfect flow control in cooling water systems where two streams flow to or from a single pipe.

The U. S. Triangle makes obsolete — in initial cost, ease of installation, maintenance, and general operating efficiency — the conventional use of separate flanged T and butterfly valves. If you're using or considering use of a T and 2 butterfly valves, a U. S. Triangle will save you money and do the job better.

U. S. TRIANGLE OFFERS:

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HERMETICS DOMINATE

(Continued from page 14)

have declined from 72,000 to 23,000 during the same period. It is also interesting to note, he said, that the hermetics have increased from 87% of the total industry shipments in 1954 to approximately 96% in 1959.

Hermetic Centrifugals, Too

During the past six years, Mr. Floreth continued, there has also been a strong growth trend of hermetic-type centrifugal compressors which are now available in water cooling systems and many other special applications in sizes ranging from approximately 75 hp to over 1,500 hp. There again, he said, the many advantages of a completely sealed, factory assembled and tested system that can be readily installed in the field with minimum labor and expense has given tremendous impetus to the industry's research and development program in this area.

PROPOSES "HYDROMECHANICS" TO SUBSTITUTE FOR "PLUMBING"

Zurn Industries, Inc., Erie, Pa., announced that it was changing the name of its plumbing division to Hydromechanics Division. According to the manufacturer of engineered plumbing drainage controls, the word *hydromechanics* more closely portrays industry functions and the professional status of the contractor than does the term *plumbing*.

The company believes that the familiar term should be replaced in all segments of the industry because it has become associated in the public mind with an "out-dated, incorrect, and in some respects unfavorable picture of the industry." The new term, however, which is defined as "that branch of physics which treats of the mechanics or laws of equilibrium and motion of liquids" is more inclusive and has the "inherent benefit of elevating its practitioners to a bona fide professional status in the eyes of the public."

HYDRONICS SHORT COURSE AT UNIVERSITY OF ILLINOIS

The 13th Annual Short Course is being offered at the University of Illinois, January 29 to February 2. Jointly sponsored by the University and I-B-R, the name of the course this year is Fundamentals of Being Competitive through Managerial and Technical Planning. It is designed for hydronic heating contractors, specifically, owners and managers. It is a supplement to the I-B-R Hydronic Heating School and not a substitute for it.

Technical sessions in the four-day program will cover such topics as heating and load calculations, bidding, and selection of equipment. They will include a tour of research facilities at the University. Sessions on management will consider business policies and growth, organization, estimating practices in relation to direct and overhead costs, advertising and promotion, and research for improved future technology.

The registration fee for the Short Course is $40.00 per person. This fee includes text materials but not food and lodging. Additional information, preliminary programs, and registration and housing forms are available on request from the Supervisor of Engineering Extension, 116D Illini Hall, Champaign, Ill.

HIGH SCHOOL STUDENTS PREVIEW COLLEGE AIR CONDITIONING

A unique preview approach to when engineering career interest of young science students is being tried at San Louis Obispo, Calif., by California State Polytechnic College.

Forty high school juniors and seniors from all over California, carefully selected with the help of science and math teachers and counsellors, were all-expense guests of the school for two days, Dec. 19 and 20, for a foretaste of engineering education on the college level.

Though only forty could be chosen, Engineering Dean Harold

P. Hayes said high school science students were so eager for the experience, though it meant sacrifice of two Christmas vacation holidays, that the college received 320 applications by deadline time.

The two-day preview was made possible by a substantial financial gift from the Western Air Conditioning Industries Association of Los Angeles, which is interested in attracting high caliber young men into the industry. Cal Poly for years was the only college in the U.S. to offer an engineering major in air conditioning.

INDUSTRY IS DEMANDING MORE MAKE-UP AIR, EXHAUST UNITS

There has been a very considerable increase in interest on the part of manager of industries in make-up air equipment, according to David R. Webster, president of Reznor Mfg. Co., Mercer, Pa.

Strangely enough, Mr. Webster said, the problem of make-up air has been in existence as long as there have been industry, but the awareness of it has only lately materialized. Ten years ago, it would be a rariety to get an industrial plant manager to listen to a make-up air story. Today the situation is reversed. Management's interest in the make-up air problem has been a source of considerable additional equipment sales, Mr. Webster stated.

Another item of greatly increased use is the mechanical exhauster, or venter. Taking the place of a flue or chimnel, it insures proper venting of unit heaters, necessary in every case to insure a satisfactory installation, Mr. Webster said. The venter costs approximately 10% of the installed cost of the average heater, and probably in the majority of cases saves anywhere from three to ten times its cost over the cost of building a satisfactory chimney or flue. In many cases, the venter is responsible for a favorable decision with respect to the purchase of unit heaters, in some cases the whole job hinges on it, he said.

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BRIEFLY STATED NEWS ITEMS

John M. Frank, chairman of the board of ILG ELECTRIC VENTILATING CO., Chicago, has been honored by his fellow executives on the 50th anniversary of his joining the company. On the occasion, Mr. Frank, whose career has encompassed many developments in the air-moving and conditioning field, predicted continued expansion in 1961 for the industry. An important contribution to the science of heating and ventilating by Mr. Frank was his invention of the propeller-fan-type unit heater, which in steam, hot water, gas and all-electric types today provides the standard method of industrial plant heating, with many commercial applications.

WITH THE ENGINEER

Coincident with the adoption of a new company name, BRUCH AND MORROW, INC., consulting engineers, have announced the addition of three new associates, Donald C. Campbell, John M. Quealy and Frank Johnson, to their staff. These appointments, in addition to Mr. Raymond A. Diekman, now increase the number of associates to four.

Mr. Donald C. Campbell is a registered mechanical engineer and a graduate of The University of Minnesota. Prior to this recent change, he was a partner in a consulting engineering office and his experience has included work on hundreds of schools, hospitals and commercial and industrial buildings in the upper midwest area.

Mr. John M. Quealy is a registered electrical engineer and a graduate of the University of Minnesota. His background includes that of electrical contracting, teaching at the University of Minnesota, engineer for Northern States Power Co., and many years as chief electrical engineer for a large architectural office.

Mr. Frank K. Johnson was recently a partner in a consulting engineering office and his experience includes twelve years in the field of mechanical design for all types of building construction. Included in these is the multi-million dollar addition to St. Mary's Hospital in Minneapolis and other notable projects in the area. . .

JOHN YELLOTT ENGINEERING ASSOCIATES, INC., announces the establishment of a Solar Energy Laboratroy to carry out research, development, and testing programs for industry, the armed services and other branches of government, and for research institutions. The Yellott Solar Energy Laboratory, 9051 N. Seventh Ave., Phoenix, Ariz., is equipped to utilize the 4200 hours of sunshine which are available annually in Central Arizona, and to render a consulting engineering service in the field of solar energy utilization. Among the types of solar equipment which can be effectively investigated in the new laboratory are: solar water heaters for swimming pools and domestic water supplies; stills; stoves and cookers; solar-electric generation; high temperature devices, such as solar furnaces, etc. . .

Edward J. Dwyer, chief engineer at JOSAM MANUFACTURING COMPANY since 1956, has been promoted to Midwest regional manager in addition to his duties as chief engineer. . .

Arthur W. Thornton has been appointed director of engineering and research of NATIONAL TUBE DIVISION, U. S. STEEL CORPORATION, it was announced. Mr. Thornton had been general superintendent of the Division's Lorain, Ohio, works. In this newly created position, he will be responsible for all engineering and research activities of the Division.

INSTITUTES AND ASSOCIATIONS

The following men were elected to office in the AMERICAN SOCIETY OF SANITARY ENGINEERING for the coming year: Arthur E. Whitney, president; Edward J. Zimmer, 1st vice-president; James C. Church, 2nd vice-president; Dewey Dedrick, Jr., 3rd vice-president; James H. Shelton, 4th vice-president; Norbert Melnick, 5th vice-president; James Christie, 6th vice-president; Wm. F. Springmyer, 7th vice-pres-

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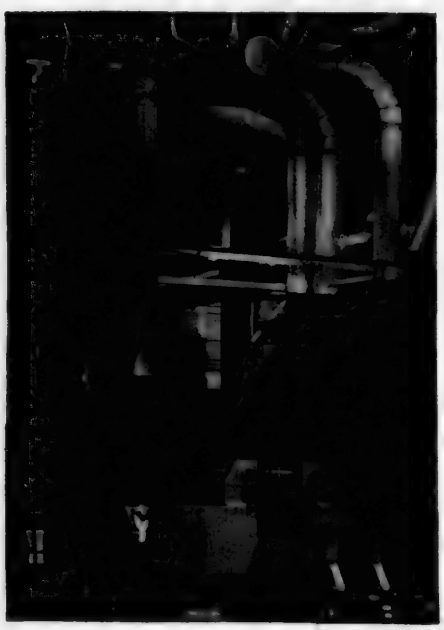

Thousands of successful installations prove that use of Flexaust hose and Portovent retractable duct with metal duct systems lower installation costs — but there are other important advantages

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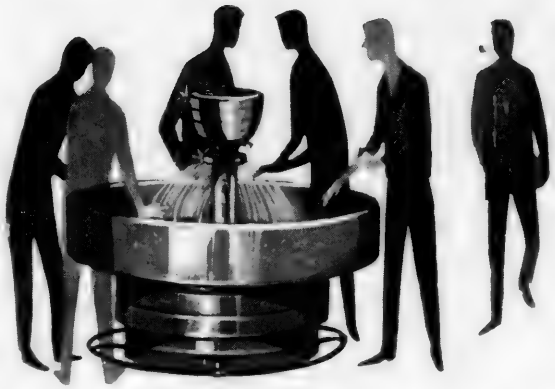
ident; Lyle Reading, 8th vice-president; John O. Risdon, 9th vice-president; Mike Mercury, treasurer; Edwin Reinieke, director, (five year term). . .

An association to promote porcelain on steel plumbing fixtures has been formed by fixture manufacturers. Frit and steel suppliers also are being called on to join the new organization. The PORCELAIN ON STEEL COUNCIL is the first association to represent this segment of the plumbing industry exclusively. It will operate as an independent council but is affiliated with the Plumbing Fixture Manufacturers Association to strengthen the entire industry and to eliminate duplication of effort. PSC offices are located at 1145 19th Street, N. W., Washington 6, D. C. . .

New officers for NATIONAL ASSOCIATION OF CORROSION ENGINEERS have been elected for 1961-62. E. C. Greco, senior research chemist for the United Gas Corp., Shreveport, La., has been elected president; Rolland McFarland, secretary and technical director of Hills-McCanna Co., Chicago, has been elected vice-president; and C. G. Gribble, Jr., district manager for the Metal Goods Corp., Houston, has been re-elected treasurer. All officers will be installed March 17, the last day of the association's 17th Annual Conference and 1961 Corrosion Show at Buffalo, N. Y. They will serve for one year. . .

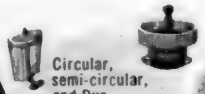
As one of the concluding activities of the recent REFRIGERATION AND AIR CONDITIONING CONTRACTORS ASSOCIATION national convention at Miami, the city of Los Angeles was selected as the site for the group's next national conclave. According to Walter McCarty, newly elected president of RACCA, the convention, which is normally staged on an annual basis, will be held in the early part of 1962 instead of in the coming year. Main reason for the change in scheduling, McCarty said, was to make it possible to hold the convention in conjunction with the national show of the Air Conditioning and Refrigeration Institute (ARI). The ARI



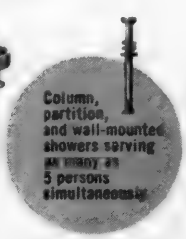
Why the big swing to Bradley Washfountains? Because only Washfountains please your clients in all these important ways: They cut installation costs 50% or more. They save an average of 25% in floor space. They eliminate disease transmission by germ-laden faucets and dirty bowls. Washfountains save maintenance man-hours and expenses . . . save water . . . and significantly speed traffic flow. For these reasons, *Washfountains gain in popularity with every passing day.*

Bradley Washfountains are available in precast stone (Granito), precast marble (black and white, sage green, and vari-colored), in stainless steel, and in vitreous enamel (forest green, mint green, sky blue, white, sun tan, citrus yellow). Sizes 54" circular and semi-circular, 36" circular and semi-circular. Heights: Standard — 29¼" . . . Junior — 25¼".

Bradley



Circular, semi-circular, and Duo Washfountains serving as many as 8 persons simultaneously.



Column, partition, and wall-mounted showers serving as many as 5 persons simultaneously.

Bradley Washfountains and Showers provide group facilities for as many as 8 and 5 persons, respectively . . . in schools and in commercial, industrial, and public buildings. For additional information, contact your Bradley representative. Or write for Publication No. 6004. Bradley Washfountain Co., 2352 W. Michigan Street, Milwaukee 1, Wisconsin.

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6800 GPH at 10-ft.

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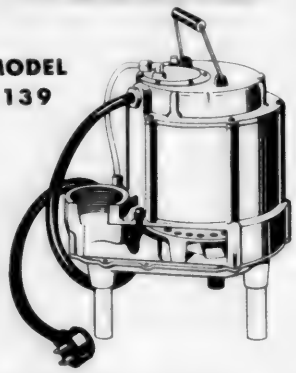

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show is also scheduled for Los Angeles during February of 1962.

NEW REPRESENTATIVES

MODINE MANUFACTURING COMPANY continued to strengthen its nationwide sales network by naming B & H Associates, Inc., Jenkintown, Pa., as its Philadelphia sales representative. B & H Associates was incorporated in March, 1960, and is active in the industrial heating markets. The company provides sales and application engineering services and is contemplating a 50% expansion of personnel. . .

Funderburgh Company, 2706A E. Central, Wichita, Kan., has been appointed a distributor of residential and commercial air conditioning, furnaces, icemakers and refrigeration products by the YORK DIVISION OF BORG-WARNER CORPORATION, York, Pa. . .

Appointment of two sales representatives to cover a four-state area for ULOK cube air filters was announced by Union Carbide Development Company, Division of UNION CARBIDE CORPORATION. They are Bell & Eiss, Inc., Minneapolis, Minn. and Ed Gifford & Company, Milwaukee, Wisc. These companies are accorded exclusive rights for ULOK cube air filters in their respective territories. . .

In line with tehe company's recently announced expansion program, ALLIED METAL HOSE COMPANY, Long Island City, N.Y., has appointed the Louis H. Hein Co., 1151 Matsons Ford Rd., West Conshohocken, Pa., as a major new stocking distributor. Hein will carry a complete line of "Allflex" flexible metal hose and connectors, on an exclusive basis in the greater Philadelphia and surrounding area.

BURGEONING BUSINESS

MARSH INSTRUMENT COMPANY, Division of Colorado Oil and Gas Corporation, announced completion and full scale operation of extensive warehousing and distributing facilities at Fort Lee, N. J. The warehousing set up will service the Eastern Seaboard. All Marsh products will be stocked at Fort Lee: pressure gages, dial thermometers, valves, refrigeration equipment and heating specialties. . .

MODINE MANUFACTURING COMPANY announced the purchase of land in McHenry County, Illinois, for anticipated future manufacturing expansion. Some preliminary grading is being done. This land acquisition follows the established pattern of company growth in the midwest. Modine was founded in Wisconsin in 1916, added an Indiana plant in 1934 and a Kentucky plant in 1946. . .

Two additions to THE TRANE COMPANY facilities in La Crosse, Wis., have been announced. One addition is a 52,500-sq-ft extension of a warehouse; the second is a 40,000-sq-ft addition to a manufacturing plant. The warehouse space, for which site preparation is already underway, will be used primarily to handle planned increases in parts and standard unit inventory, plus some light assembly operations. The new manufacturing space will permit enlargement of production facilities for large centrifugal compressors and the company's Hermetic Absorption Cold Generator. . .

A. O. SMITH CORPORATION will build an advanced research center at Middleton, Wis., at an estimated cost of $2 million. This is in addition to its modern, seven-story research building in Milwaukee, Wis. Ground would be broken on an 80-acre tract of land. It is planned to begin research activities in the new facility by the middle of 1961. . .

Acquisition of Rochester Manufacturing Company, Inc., Rochester, N.Y., by AMERICAN RADIATOR & STANDARD SANITARY CORPORATION, New York, was announced. The Rochester Company will now be operated as a part of the Detroit Controls Division of American-Standard, Detroit, Mich.

Rochester Manufacturing Company, formed in 1915 to make fuel gages for automobiles, is a leading producer of liquid level, pressure, and temperature indication gages and instruments used in a number of important industries, principally

chemical, food processing, machine tools, marine, petroleum, and power. . .

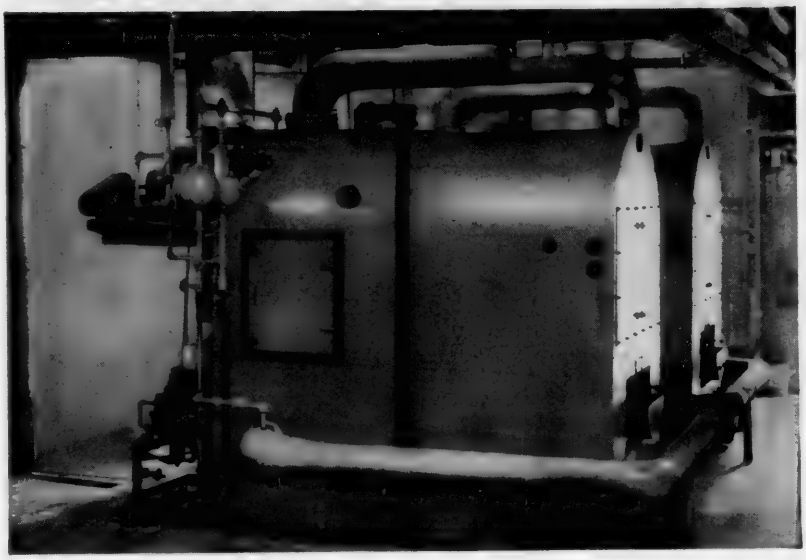
In a program to increase AMERICAN-STANDARD'S effectiveness in marketing air conditioning products, its INDUSTRIAL DIVISION has been assigned full responsibility for all sales of fan-coil and through-the-wall units not sold through wholesale channels. The first step taken by the Industrial Division since assuming this responsibility is the establishment of a Remotaire training program for sales personnel. Division sales force will be trained to sell and service the full line of Remotaire units." (The Remotaire line of peripheral room air conditioners includes both self-contained through-the-wall units and fan coil units to be served by central station refrigeration and heating sources.)

In a simultaneous action, the Industrial Division has announced discontinuation of the American-Standard Diaflo line of room air conditioners. . .

Announcement of the sale of a 55 year old Los Angeles manufacturing concern to John J. Pivovaroff has been made by B. Christian Berg, former president of SCHURS OIL BURNER COMPANY, Los Angeles, Calif. Mr. Pivovaroff, former plant manager of Pioneer Aluminum Company, indicates that the company will continue to manufacture quality oil and gas burners and allied equipment for the industrial heating and manufacturing fields. . .

HI-PRESS AIR CONDITIONING OF AMERICA, INC., will acquire the assets of the DRAYER-HANSON DIVISION of the CRANE CO. under terms of an agreement approved by both companies and effective December 15, 1960, S. W. Brown, president of Hi-Press announced. The Drayer-Hanson Division, with its headquarters and plant in Los Angeles, is one of the nation's leading manufacturers of low-side air conditioning components and also produces a line of refrigeration, heating, and heat transfer equipment. Established a half a century ago, Drayer-Hanson has its major marketing

VITRO LABS DEPEND ON IBW COMPAKS



Fast heating . . . low operating cost . . . water tube boiler efficiency and dependability —these are key features of the International COMPAK Generators at the Silver Spring, Md. plant of Vitro Laboratories, a division of Vitro Corporation of America.

These fully automatic package units respond instantly to changing load demands—a big plus advantage of International water tube design featuring rapid and directed internal water circulation.

Learn the true value of International boilers, where . . . "a little more buys a lot more" in dependability, economy and long life service.

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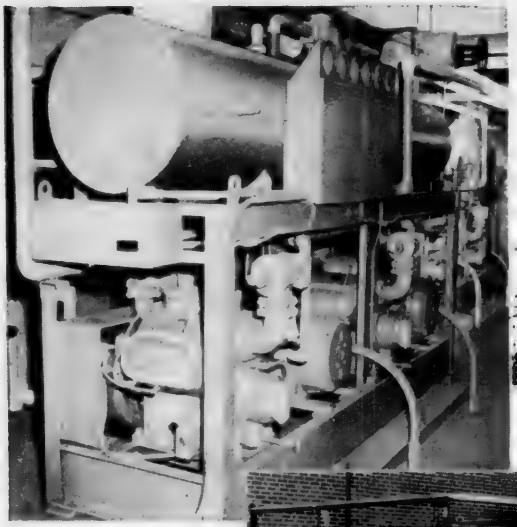
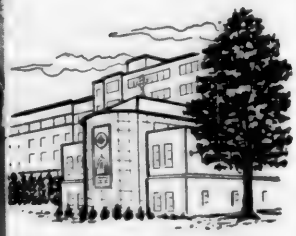
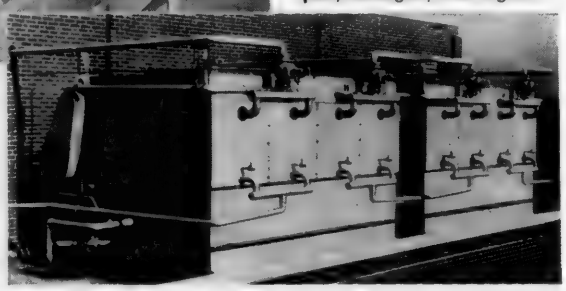
With Vilter air conditioning... it's almost a pleasure to be a patient here



View of the two Vilter packaged water chilling units arranged as four independent refrigeration systems. Two Vilter VMC compressors are included in each chiller unit.



New addition to St. Mary's Hospital, Huntington, West Virginia.



View of the two Vilter evaporative condensers, one for each packaged unit. Each condenser is divided into two separate sections to efficiently reduce capacity when required.

Efficient, flexible, quiet—the Vilter installation for the new addition at St. Mary's Hospital provides everything a hospital requires of an air conditioning system.

This system is designed around two separate Vilter Refrigerant 22 packaged water chilling units arranged as four independent systems supplying a total of 300 tons of refrigeration.

The performance advantages are — (a) an exceptionally flexible operating plant because of the four systems and the 33% and 66% capacity modulation built into each compressor; (b) lower starting and operating noise levels as a result of dividing the full load and using modern slow speed equipment; (c) maximum insurance against failure; (d) ease of servicing.

Four Vilter VMC compressors, V-belt driven from 75 H.P. motors, individually develop 76 tons as each water chiller cools 440 gpm from 53° F. to 45° F. with a 35° F. refrigerant temperature. Two Vilter evaporative condensers are utilized with each condenser divided by a baffle to actually provide four separate 100-ton units.

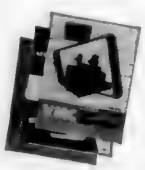
You benefit doubly with Vilter refrigeration and air conditioning equipment—(1) careful design for long life and reliable, efficient performance; (2) a complete and integrated line of equipment, and the experience to counsel you on the best type of installation. Why not let the nearest Vilter representative help you?

Sold by Vilter Distributor, Commercial Refrigeration Sales, Inc., Huntington, West Virginia.
Architect, Vecellio & Kreps; Consulting Engineer, L. O. Johnson; Mechanical Contractor, Dougherty Company, Inc.

Vilter® refrigeration air conditioning

The Vilter Manufacturing Company
Milwaukee 7, Wisconsin

Air Units • Ammonia and Freon Compressors • Booster Compressors Baudelot Coolers • Water and Brine Coolers • Blast Freezers Evaporative and Shell and Tube Condensers • Pipe Coils Valves and Fittings • Pakice and Polarflake Ice machines.



Write for Bulletins 820, 631 and 932 to The Vilter Manufacturing Company, Dept. G-601 2217 South First Street Milwaukee 7, Wisconsin

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areas in the southern and western states. Drayer-Hanson was acquired by the Crane Co. when it purchased the assets of National-U.S. Radiator Co. early this year.

Hi-Press designs and manufactures an advanced system of noiseless and draftless air conditioning employing small diameter piping for the high velocity distribution of the conditioned air.

PERSONNEL ITEMS

Appointments of Norman F. Heydinger and Robert L. Morgan to the newly-created positions of manager-marketing services and manager-woven textile marketing, respectively, in the firm's Fiber Glass Division have been announced by PITTSBURGH PLATE GLASS COMPANY, Pittsburgh, Pa. . .

Robert Salsbury has been promoted to the position of general manager of the JAY R. SMITH MANUFACTURING COMPANY. Mr. Salsbury joined the company in 1957 as plant manager and has been in charge of all production for the company's line of drains, carriers, interceptors and other engineered plumbing products. . .

Arthur Sternberg, president of Solar Permanent division of U. S. Industries, Inc, has been appointed assistant vice-president for operations at FAIRBANKS, MORSE & Co., it was announced. . .

Frank J. Nunlist has been appointed to the new position of vice-president-operations of WORTHINGTON CORPORATION, it was announced. In his new position Mr. Nunlist, formerly a group vice-president, will be responsible for the activities of all the company's sixteen domestic operating divisions in ten states and regional engineering and service activities. He will report to Walther H. Feldmann, president. . .

WARREN WEBSTER & COMPANY, INC., has named A. Richard Webster to the post of vice-president-school equipment sales. This move coincides with the corporation's recent addition of a full line of unit ventilators designed specifically for

school application. Mr. Webster is the grandson of the founder of this 72 year old company. . .

Joseph Smith has been appointed advertising manager of A. M. BYERS COMPANY, Pittsburgh, Pa. Mr. Smith joined the company in 1955, and has been assistant advertising manager and in charge of product public relations. . .

Appointment of A. J. Simpson as product manager for all division fan lines has been announced by AMERICAN-STANDARD INDUSTRIAL DIVISION. In his new position, Mr. Simpson will be responsible for market planning and product development relating to fans for commercial, industrial and power plant application. . .

LENNOX INDUSTRIES INC., Marshalltown, Iowa, announced the promotion of Robbie L. Stephens to the position of sales manager, a newly created post at the Decatur, Georgia, headquarters of the company. Until his recent transfer, Mr. Stephens has been manager of air conditioning at Lennox-Fort Worth, a post he held since 1955. . .

Roland E. Pillat has been named sales manager for TYPHOON HEAT PUMP DIVISION, Hupp Corporation, Tampa, Fla. Since 1953 Mr. Pillat has been a partner in a Seattle manufacturer representative agency selling Typhoon air conditioning and heat pump products in the northwest and Alaska. . .

JOSAM MANUFACTURING COMPANY announced the appointment of R. L. "Lou" Tucker as Eastern Regional Manager. Mr. Tucker's first association with Josam was in 1926 when he joined the staff of the Chicago District Representative. Later he spent some time in the New York office. Most recently he has been the District Representative in the New England territory. . .

Lavern H. Brenneman was elected president and general manager of YORK-SHIPLEY, INC. at a special meeting of the Board of Directors

(Concluded on page 133)

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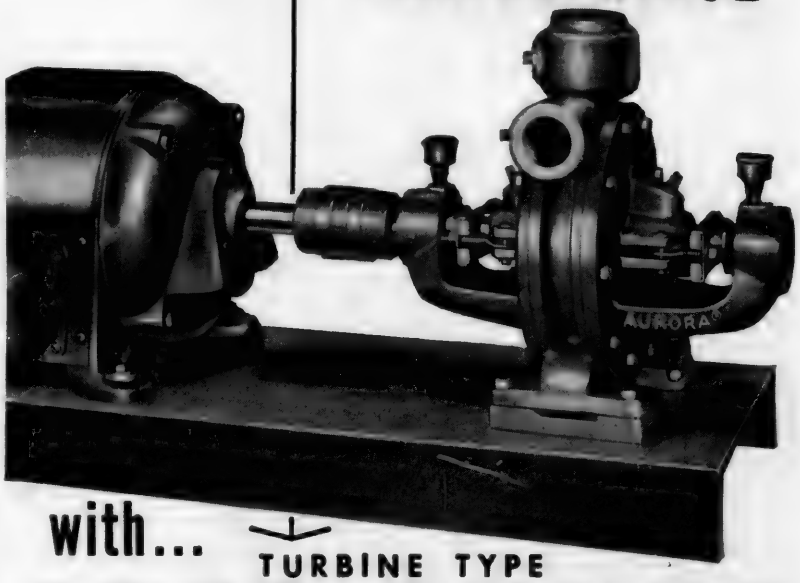

with... TURBINE TYPE APCO PUMPS

- PROVEN DEPENDABILITY
- CALCULATED CAPACITIES
- RUGGED CONSTRUCTION
- HIGHEST QUALITY CONTROL
- APPLICATION ANALYSIS
- SELECTED COMPONENTS
- MINIMIZED WEAR
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- PRESSURES TO 400 P.S.I.
- CAPACITIES TO 150 G.P.M.

Ruggedness of construction and simplicity of design of APCO turbine type pumps combine to provide longer life, high efficiency, and minimized down time. This means more for your "pump operating dollar." With APCO *steep impeller* characteristics there is little capacity change under fluctuating head conditions. Select from the "1001" types, sizes, and capacities of AURORA pumps to obtain *the one* specifically designed to fit your needs.

APCO turbine type pumps are most frequently used for: Boiler Feed, Condensate Return, Fresh Water Service, Brine Service, Ice Water Circulation, Filter Service, LPG Service, Transfer Service, Caustic Liquid Handling, Sprinkler Service, Spraying Service, Water Treatment, Booster Service, and High Temperature Service.

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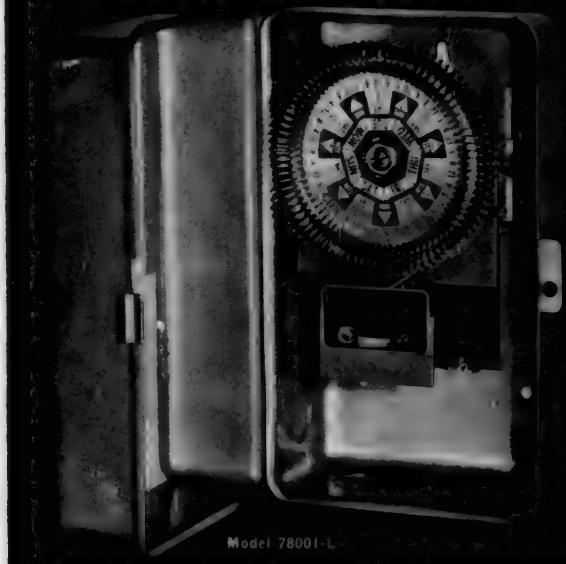
DESPITE POWER FAILURE

7-Day Time Switch with
20 Hour RESERVE POWER!



Ideal Control for Heating, Air Conditioning, Ventilating, and Lighting in Schools, Public Buildings and Offices.

Check These Exclusive TORK *Features:*

- Should power fail precision spring mechanism takes over instantly . . . keeps on time for 20 hours!
- When power resumes electrically wound spring rewinds 10 times faster than used.
- Up to 12 operations a day with 2 hour minimum settings. Dial revolves once a week permitting longer or shorter periods of operation for each individual day, as well as skipping selected days.
- Choice of easy-to-set tab-type tripper dial . . . OR conventional ON-OFF dial!
- Available with Single Pole Single Throw, Double Pole Single Throw, Single Pole Double Throw, and Double Pole Double Throw switching.
- Highest capacity of any 7-Day Time Switch . . . up to 55 Amperes per pole.
- Compact, rugged design . . . same size as 24 hour models!
- Available without case, with bracket . . . or with Flush Enclosure, for panel mounting!

Here is the safest, most dependable Time Switch made . . . designed to meet the highest quality standards of Consulting Engineers and Architects. Insures comfort — no danger of Time Switch failing to operate when needed due to power failure. Economical too! No need for service screws to reset Time Switch after power failure.

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In Canada: DOMINION ELECTRIC MANUFACTURING CO., LTD., TORONTO
Most Complete Line of Time Switches for Heating, Ventilating, Air Conditioning, Refrigeration, Water Softening, Sewage Disposal, Pumping, and General Electrical Applications.

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Design of Water Systems

(Concluded from page 82)

velocity would be somewhat greater. The length of the circuit will also affect these general conclusions as expressed earlier.

Variable Flow System

For a variable flow system, Fig. 2, the circulating system is similar to that often used for room fan coil units when located on different floors. It could serve an office, hotel or apartment.

The system has reversed return and indirect risers which, in effect, provides substantially the same pressure difference across each unit in the system. This condition will prevail throughout a fairly wide change in the flow rate. Location of balance tank, vent and drains are important as explained for the previous layout.

The system pressure level at design flow and at 70% flow are plotted in the lower portion. The correction for head developed by the pump at partial flow has been included in the analysis. At 70% flow, the system friction drop is approximately 50% of design while the head developed by the pump is approximately 110% of design. This excess may be absorbed by several different means. Examples are an automatically controlled throttling valve at the pump, a pump bypass, or capacity control valves at each unit. This analysis shows the excess pressure being absorbed by the capacity control valve at the unit. Note that the pressure drop at this point will be approximately 40 feet at 70% flow. This means that the velocity through the port of the capacity control valve will be approximately 51 fps. Such a velocity may produce an objectionable noise.

Details of System

The excess head developed by the pump under this reduced flow could be absorbed by an automatically controlled throttling valve at the pump. The index location, under consideration, may be in the supply header thus correcting for the change in friction between its location and the balance tank connection (point E). A bypass around pump and cooler and piloted from the same point will provide similar correction. It would assure approximately constant flow through the cooler but at a slightly higher operating cost. Three-way mixing type capacity control valves at each unit will also correct for such difficulties but possibly at a higher first cost.

Generally speaking, the instantaneous demand of the units is seldom equal to the sum total due to diversification of load. From the practical standpoint and based on experience, the pump design capacity will be approximately 65% to 75% of the sum total of the units. The pump and headers could be sized for this lesser amount.

Variable flow systems can be made to operate satisfactorily throughout a wide flow range if proper consideration is given to pump selection, method of correcting for excess pressure, balance tank location, vents and location.

COMING EVENTS

Where listed, names or titles of individuals are those from whom further information is available.

EXPOSITION OF AUTOMOTIVE ENGINEERING—International Congress and Exposition of Automotive Engineering, sponsored by the Society of Automotive Engineers, Inc., at Cobo Hall, Detroit, Mich. J. Gilbert, secretary of the Society, 485 Lexington Ave., New York 17, N. Y. ..... **JANUARY 9-13, 1961.**

INSTRUMENT-AUTOMATION CONFERENCE—ISA Winter Instrument-Automation conference and exhibit, at Kiel Auditorium, St. Louis, Mo. Wm. H. Kushnick, executive director of the Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa. ..... **JANUARY 17-19, 1961.**

PLANT MAINTENANCE CONFERENCE—1961 Plant Maintenance & Engineering Conference at the International Amphitheatre, Chicago, Ill. Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. ..... **JANUARY 23-26, 1961.**

HYDRONICS HEATING SHORT COURSE—13th annual Short Course on Hydronic Heating and Cooling, at the University of Illinois, under the joint sponsorship of the University and The Institute of Boiler & Radiator Manufacturers. W. K. Newton, Supervisor of Engineering Extension, 116D Illini Hall, Champaign, Ill. ..... **JANUARY 30-FEBRUARY 2, 1961.**

ASHRAE MEETING—Semi-annual meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., at the Conrad Hilton Hotel, Chicago, Ill. Secretary, Robert C. Cross, 234 Fifth Ave., New York 1, N. Y. ..... **FEBRUARY 13-16, 1961.**

HEATING AND AIR CONDITIONING EXPOSITION — International Heating and Air Conditioning Exposition, at the International Amphitheater, Chicago, Ill. E. K. Stevens, International Exposition Co., 480 Lexington Ave., New York 17, N. Y. ..... **FEBRUARY 13-16, 1961.**

NATIONAL SYMPOSIUM ON TEMPERATURE—Third National Symposium on Temperature—Its Measurement and Control in Science and Industry, sponsored jointly by the American Institute of Physics, Instrument Society of America, and the National Bureau of Standards, to be held in Columbus, Ohio. C. L. Roberson, ISA, 313 Sixth Ave., Pittsburgh 22, Pa. ..... **MARCH 27-31, 1961.**

CORROSION ENGINEERS CONFERENCE—Annual Conference and Corrosion Show of the National Association of Corrosion-Engineers, at the Statler Hotel, Buffalo, N. Y. T. Hull, executive secretary of the Association, 1061 M&M Building, Houston 2, Tex. ..... **APRIL 5-7, 1961.**

INDUSTRIAL HYGIENE CONFERENCE — Annual American Industrial Hygiene Conference at the Sheraton-Cadillac Hotel, Detroit, Mich. Publicity chairman, J. D. MacEwen, Wayne State University, 1401 Rivard St., Detroit 7, Mich. .... **APRIL 9-13, 1961.**

CONVENTION ON WELDING—Annual convention of the American Welding Society. The Coliseum, New York, N. Y. For information write, American Welding Society, 33 W. 39th St., New York 18, N. Y. ..... **APRIL 18-20, 1961.**

CONSULTING ENGINEERS COUNCIL—Annual meeting of the Board of Directors of Consulting Engineers Council, at Executive House, Chicago, Ill. Executive Secretary, L. N. Spiller, 326 Reisch Bldg., Springfield, Ill. ..... **MAY 4-6, 1961.**

DESIGN ENGINEERING CONFERENCE AND SHOW—Design Engineering Show, Cobo Hall, Detroit, Michigan. Exposition management by Clapp and Poliak Inc., 341 Madison Ave., New York 17, N. Y. ..... **MAY 22-25, 1961.**

NDHA MEETING—Annual meeting of the National District Heating Association, Wentworth-by-the-Sea, Portsmouth, N. H. Secretary, John F. Collins, Jr., 827 N. Euclid Ave., Pittsburgh 6, Pa. ..... **JUNE 12-15, 1961.**

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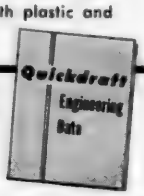

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BOOK REVIEWS

Publications abstracted in this department should be ordered direct from publisher.

HYDRAULIC STANDARDS

In 1955, the Hydraulic Institute issued a basic text titled Standards of the Hydraulic Institute. The first revision of the tenth edition of these standards is now available as loose leaf pages to be inserted into the original volume. The revisions are printed on colored stock so that when the sheets are slipped into the book, it will be easy to locate the revised pages.

Some of the important changes in the revisions are new definitions, dimensions of NEMA type-C face-mounted motors; NPSH charts for centrifugal hot water pumps, single and double suction; revisions in the test code for centrifugal pumps, and calculations for volumetric efficiency of reciprocating pumps.

Revisions for Standards of the Hydraulic Institute, 10th Edition. Set includes 75 pages, 8½ x 11 inches. Published by Hydraulic Institute, 122 E. 42nd St., New York 17, N. Y. Price $1.25.

SCHOOL BUILDINGS

Instructions for operating mechanical and electrical equipment found in the modern school building, are presented in Mechanical-Electrical Equipment Handbook for School Buildings, by Harry Terry, consulting engineer. This book has information on the installation, maintenance and use of such equipment.

Since the mechanical and electrical equipment in a school represents 25% of the cost of the building, it is important that such equipment be properly installed, maintained and operated.

Some of the chief subjects discussed are heating, air conditioning, plumbing, sewage disposal, kitchen and cafeteria equipment, illumination and electric wiring.

Mechanical-Electrical Equipment Handbook for School Buildings, by H. Terry. Cloth bound, 6 x 9 inches, 412 pages. Published by John Wiley & Sons, Inc., 440 Park Ave. S., New York 16, N. Y. Price, $9.50.

DICTIONARY OF PLUMBING TERMS

A large number of terms used in the plumbing industry are illustrated and described in An Illustrated Dictionary of Plumbing Terms, by Evan Berry. While the author realizes that it is impossible to cover all the terms in use in the plumbing and allied industries, in a book of this size, he hopes that he has provided a wide and useful selection of terms. In all, 336 terms are covered.

An Illustrated Dictionary of Plumbing Terms, by E. Berry. Cloth bound, 4 x 7¼ inches, 244 pages. Published by Philosophical Library, Inc., 15 E. 40th St., New York, N. Y. Price, $6.

(Concluded on page 134)

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Briefly Stated

(Concluded from page 129)

of the Company, according to Samuel H. Shipley, Sr., newly elected chairman of the Board of Directors, who held the post of President during the past twenty years. . .

Lee Zoeckler has been appointed manager of sales and product training of PERMAGLAS DIVISION OF A. O. SMITH CORPORATION, Kankakee, Ill. . .

Leonard (Lee) Nechine has been appointed assistant manager of CHICAGO PUMP, manufacturer of pumps and sewage treatment equipment. Formerly operations manager, he has served in various capacities with Chicago Pump for the past twenty-one years. . .

The following personnel items were submitted by YORK DIVISION OF BORG-WARNER CORPORATION:

Robert E. Regan, Haddonfield, N.J., has been appointed a district sales manager. He will cover Pennsylvania, Maryland, Virginia, and Washington, D.C. He will devote most of his time to the firm's line of room air conditioners.

The man credited with the longest span of years as a sales executive in the packaged air conditioning and refrigeration industry has "semi-retired." W. E. "Walt" Landmesser, general sales manager for packaged products, will take things a little easier after 38 years in the industry. When he started, the domestic electric refrigerator was breaking out of its shell.

OBITUARIES

Martin E. Snyder, 60, and Nemesio J. Manasco, 55, veteran BUENSOD-STACEY CORPORATION executives, passed away within hours of each other in New Jersey hospitals on November 28. Mr. Snyder, a financial specialist who joined Buensod in 1948, was the company's assistant secretary. Mr. Manasco had been with the pioneer air conditioning firm since 1938 and, as engineer, acted as Buensod's liaison with the Public Service Gas & Electric Company in Newark, N. J. on all installations for which Buensod held the contract.

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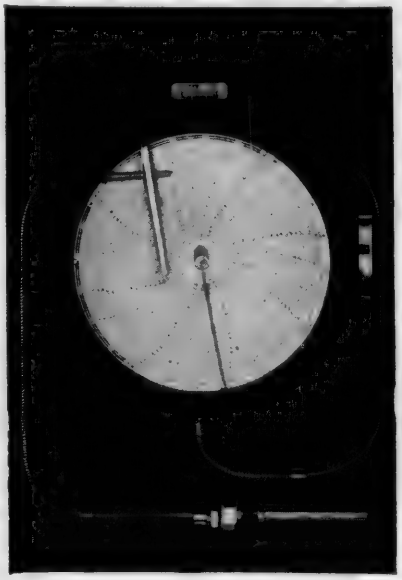

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(Continued from page 132)

MINE VENTILATION—D. S. Kingery, director, Health and Safety Research and Testing Center, U. S. Bureau of Mines, is the author of Bulletin 589 on Introduction to Mine Ventilating Principles and Practices. This bulletin was prepared for use by mine personnel interested in and responsible for mine ventilation operations. It is written in layman language and presupposes only an elementary knowledge of mine ventilation and algebra. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 40 cents.

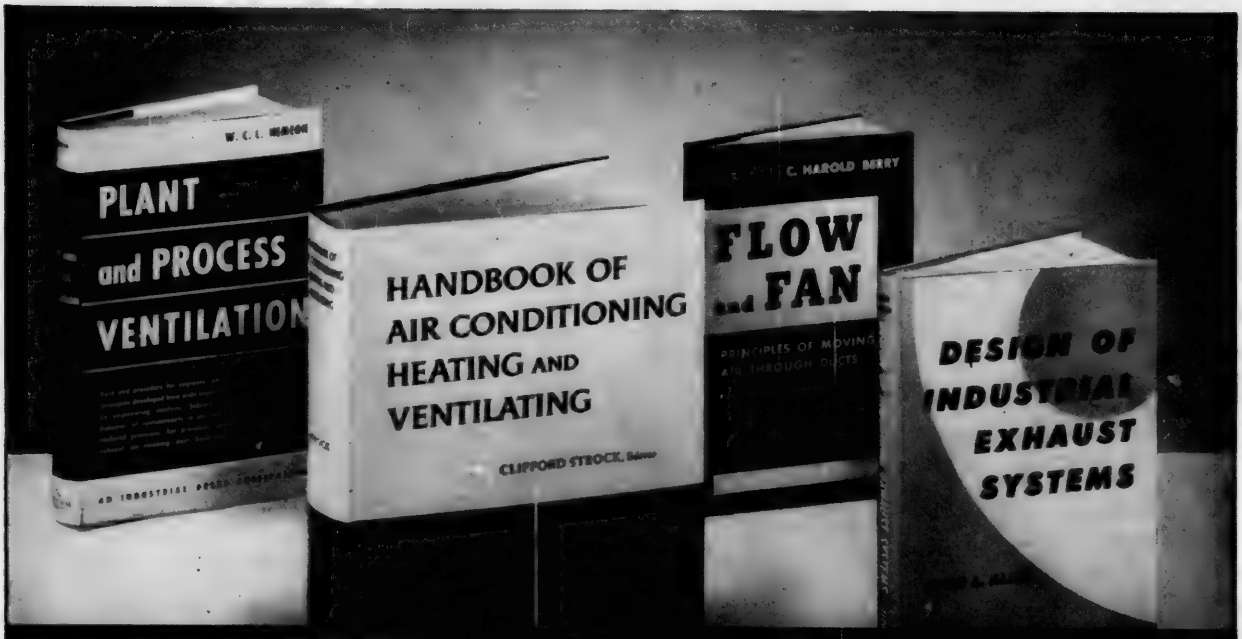
RESEARCH ON HYDRONIC HEATING AND COOLING—A summary of the results of the IBR research program over the past 20 years is presented in a booklet issued by the University of Illinois on Summary, Cooperative Research on Hydronic Heating and Cooling. It was sponsored by the Institute of Boiler and Radiator Manufacturers. This program of research was carried out under the terms of a cooperative contract between IBR and the University. Engineering Experiment Station, University of Illinois, Urbana, Ill.

INSULATED MASONRY CAVITY WALLS—Papers and discussions on the subject of insulated masonry cavity walls that were presented as part of the 1960 BRI Spring Conference are now available as Publication 793. Building Research Institute, 2101 Constitution Ave. N. W., Washington 25, D. C. Price, $4.

Canadian Degree-Days for November 1960*

City	November		Cumulative	
	1960	Normal	1960	Normal
Calgary, Alta.	1184	1110	2201	2230
Charlottetown, P. E. I.	801	850	1655	1640
Crescent Valley, B. C.	1012	990	2074	2000
Edmonton, Alta.	1261	1220	2333	2410
Fort William, Ont.	1020	1170	2091	2280
Grande Prairie, Alta.	1331	1300	2497	2550
Halifax, N. S.	672	745	1321	1404
London, Ont.	750	840	1386	1480
Medicine Hat, Alta.	1142	1070	1925	1970
Moncton, N. B.	830	910	1756	1760
Montreal, P. Q.	739	910	1461	1650
North Bay, Ont.	898	1080	1861	2070
Ottawa, Ont.	773	970	1531	1750
Penticton, B. C.	829	820	1579	1540
Prince George, B. C.	1110	1110	2325	2320
Quebec, P. Q.	888	1030	1846	1930
Regina, Sask.	1341	1290	2005	2410
Saint John, N. B.	799	880	1711	1750
Saskatoon, Sask.	1360	1320	2377	2460
Timmins, Ont.	1059	1270	2258	2460
Toronto, Ont.	663	777	1160	1396
Vancouver, B. C.	645	650	1310	1310
Victoria, B. C.	616	600	1326	1240
Windsor, Ont.	702	780	1156	1310
Winnipeg, Man.	1194	1255	2115	2252

* These data are supplied through the courtesy of the Meteorological Division, Air Service Branch, Department of Transport, Canada.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PLANT AND PROCESS VENTILATION. By W. C. L. Hemeon. 448 pages, 172 illustrations. The book and its author have contributed original ideas that have led to the modern engineering approach to ventilation design. The book covers fundamentals and properties of all types of air contaminants, a new treatment of dynamics of dust particles and the design of exterior hoods using a new conception enabling designer to estimate exhaust requirements of a cold, multi-directional process by observation. From chapters on estimation of exhaust, heat and general ventilation, the plant engineer can derive a sound, quantitative, independent judgment of factors pertinent to the design. Mr. Hemeon presents a theory for estimating air flow that is induced by the motion of solid particles. He reduces formulas to tabular and graphical form for direct application. Discusses application of behavior of hot contaminated air to design of canopy and exhaust hoods. From exhaust hood rates he leads into new equations to prevent contamination of process due to leakage. He also explains: methods of moving air, natural drafts, roof ventilation, large building air currents and exhaust air cleaning.

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HANDBOOK OF AIR CONDITIONING, HEATING AND VENTILATING. Edited by Clifford Strock. 1094 pages, 518 illustrations. A wealth of working data for design engineers in ventilating, heating, air conditioning, piping and plumbing and related fields. 84 pages are devoted to air handling and ventilation and cover such subjects as air flow in ducts, duct friction losses, duct system design, determining required air volume, heat capacity of ducts, testing exhaust ventilating systems, corrosion of fans and ducts, exhaust hoods, weight of metal in rectangular ducts and circular ducts, weight of nonferrous sheets, commercial air cleaners, selector for air cleaners, fan arrangements, fans and blowers, threshold limits of toxic fumes and dust, dust collection. $15.00

DESIGN OF INDUSTRIAL EXHAUST SYSTEMS. By John L. Alden. Third Edition. 256 pages, 137 illustrations. Classic text on designing, building and buying industrial exhaust systems brought up-to-date to meet modern standards of industrial environment. Among the new advances and developments it treats are: fog filters, reverse flow filters, venturi scrubbers and multiple miniature cyclones. The book is the ideal source of information for anyone concerned with the industrial environment. Typical of its practical value are the drawings and detailed specification for hoods serving a wide variety of industrial situations. And it demonstrates the use of data and design principles with an example of how to design a system. $6.00

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ALPHABETICAL INDEX OF ADVERTISERS

A

A-J Manufacturing Co. 120
Aerofin Corp. ..... *
Aerovent Fan Co., Inc. 117
Air Conditioning, Inc. 2
Air Devices, Inc. 121
Air Filter Corp. 119
Air Filter Institute ..... *
Air Moving & Conditioning Association, Inc. ..... *
Airtemp Div., Chrysler Corp. 32
Allin Manufacturing Co. ..... *
Alnor Instrument Co., Div. Illinois Testing Laboratories, Inc. 116
American Gas Association ..... *
American Gilsonite Co. 34
American Machine & Metals Inc. .... *
American-Standard Industrial Div. ... *
Anaconda American Brass Co. 13
Anemostat Corp. of America 40
Apextro Products Co. ..... *
Armstrong Machine Works ..... *
Arno Adhesive Tapes, Inc. 131
Aurora Pump Div., New York Air Brake Co. 129

B

Babcock & Wilcox Co., Boiler Div. ... *
Baker-Roos Inc. ..... *
Barber-Colman Co. ..... *
Barnebey-Cheney Co. 11
Bell & Gossett Co. 21
Bethlehem Steel Co. 29
Bituminous Coal Equipment, Inc. 118
Bradley Washfountain Co. 125
Bryan Steam Corp. 38
Buensod-Stacey Corp. 17
Buffalo Forge Co. 15

C

Chicago Pump, Hydrodynamics Div., Food Machinery & Chemical Corp. 24
Chrysler Corp., Airtemp Div. 32
Clarage Fan Co. ..... *
Classified Advertisements 138
Cleaver-Brooks Co., Boiler Div. ..... *
Coyne & Delany Co. 5

D

DeBothezat Fans Div., American Machine & Metals, Inc. ..... *
Dwyer, F. W., Manufacturing Co. ... *

E

Elgo Shutter & Mfg. Co. 121

F

Field Control Div., Conco Engrg. Works, Inc. ..... *
Fifteenth International Heating & Air-Conditioning Exposition 30-31
Flexaust Co. 124
Fluor Products Co. 9

G

Gustin-Bacon Manufacturing Co. 41

H

Halstead & Mitchell 1
Harris, Arthur & Co. ..... *
Henry Valve Co. .....Inside Back Cover
Hoffman Specialty Manufacturing Corp. ..... *

I

Ilg Electric Ventilating Co. ..... *
Industrial Press 135
International Boiler Works Co. 127
International Heating & Air-Conditioning Exposition 30-31
Iron Fireman Manufacturing Co. 35

J

Jenkins Bros. .....Inside Front Cover
Jenn-Air Products Co., Inc. ..... *
Johns-Manville 42-43
Johnson Service Co. 20
Josam Manufacturing Co. ..... *

K

Kenco Pump Div., American Crucible Products Co. 126

L

Lawler Automatic Controls, Inc. 36
Lehigh Fan & Blower Div., Fuller Co. *
Lennox Industries, Inc. 114-115

M

Marsh Instrument Co., Div. Colorado Oil & Gas Corp. 113
McDonnell & Miller, Inc. .....Back Cover
McQuay, Inc. 19
Metropolitan Refining Co., Inc. 123
Minneapolis Honeywell Regulator Co. 22-23

N

Nash Engineering Co. 44
National Tube Div., United States Steel Corp. ..... *
New York Blower Co. 37
Niagara Blower Co. ..... *

P

Palmer Thermometers, Inc. 138
Patterson Kelley Co., Inc. 16
Penn Ventilator Co., Inc. ..... *
Pittsburgh Plate Glass Co. 25
Powers Regulator Co. 6-7

Q

Quickdraft Corp. 132

R

Reading Tube Corp. ..... *
Ready-Power Co. ..... *
Research Products Corp. ..... *
Reznor Manufacturing Co. ..... *

S

Sarco Co., Inc. 33
Skidmore Corp. 28
Sloan Valve Co. 18
Smith, Jay R., Mfg. Co. 134
Sporlan Valve Co. 109
Spraying Systems Co. ..... *
Sterling, Inc. ..... *
Sturtevant Div., Westinghouse Electric Corp. 39
Symmons Engineering Co. ..... *
Synchronous Flame, Inc. 121

T

Taco Heaters, Inc. ..... *
Thermal Engineering Corp. ..... *
Tork Time Controls, Inc. 130
Trane Co. 26-27
Typhoon Air Conditioning Div., Happ Corp. 111

U

United States Steel Corp., National Tube Div. ..... *
United States Valve & Engineering Co. 122

V

Vilter Manufacturing Co. 128

W

Wade Manufacturing Co. ..... *
Wagner Electric Corp. ..... *
Waterloo Register Co., Inc. ..... *
Watsco, Inc. 121
Weil-McLain Co. ..... *
Weil Pump Co. ..... *
Western Engineering & Mfg. Co. .... *
Westinghouse Electric Corp., Sturtevant Div. 39
Wiremold Co. ..... *

* Advertiser appeared in preceding issue

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13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108
109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132
133	134	135	136	137	138	139	140	141	142	143	144

CIRCLE PAGE NUMBERS BELOW FOR AD INQUIRIES

Covers:		Inside Front				Inside Back			Back		
1	2	5	6	7	9	11	13	15	16	17	18
19	20	21	22	23	24	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43
44	109	111	113	114	115	116	117	118	119	120	121A
121B	121C	121D	122	123	124	125	126	127	128	129	130
131	132	133A	134	135	136						

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1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108
109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132
133	134	135	136	137	138	139	140	141	142	143	144

CIRCLE PAGE NUMBERS BELOW FOR AD INQUIRIES

Cover:	Inside Front					Inside Back					Back
1	2	5	6	7	9	11	13	15	16	17	18
19	20	21	22	23	24	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43
44	109	111	113	114	115	116	117	118	119	120	121A
121B	121C	121D	122	123	124	125	126	127	128	129	130
131	132	133A	134	135	136						

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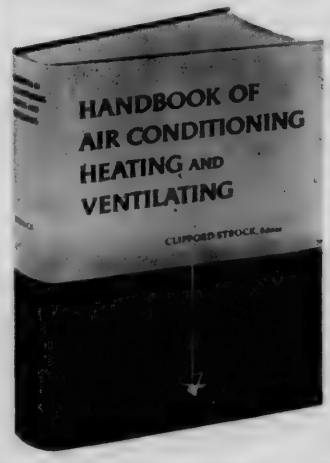

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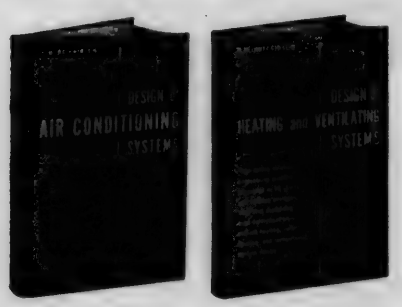

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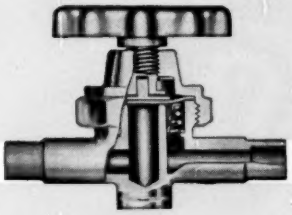

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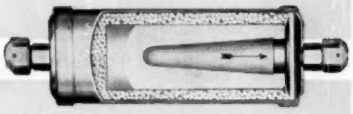

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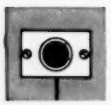
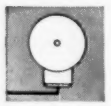
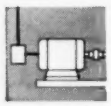


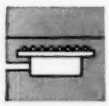
to actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearing and so on.



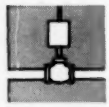
to sound an alarm—when flow stops in a process system or in any water cooled devices.



to start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling systems when flow stops. These are *control* functions, and almost endless.



to start or stop automatic burners—start a booster heater when water draw occurs; stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



to actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

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